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H. W. WILEY, Chief of Bureau.

MEAT EXTRACTS AND SIMILAR PREPARATIONS,

INCLUDING STUDIES OF THE METHODS OF ANALYSIS EMPLOYED.

BY

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Chemistry,
Washington, D. C., October 19, 1907.

Sir: I have the honor to transmit herewith the results of a chemical study of various preparations made from meat, and some substances used to adulterate such products. In addition, comments on the nutritive value of meat extracts and similar products have been compiled from the literature of the subject. The wide use of preparations of this nature by invalids and others seeking a concentrated nutritious food rather than a stimulant, and the fact that but little is generally known of the actual composition of these products, make it advisable to publish the information obtained in the course of these studies, which were primarily conducted for the establishment of standards.

I recommend that this manuscript be published as Bulletin 114 of the Bureau of Chemistry.

Respectfully,

H. W. Wiley,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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MEAT EXTRACTS AND SIMILAR PREPARATIONS, INCLUDING STUDIES OF THE METHODS OF ANALYSIS EMPLOYED.

CHEMICAL EXAMINATION.

OBJECTS OF THE INVESTIGATION.

For several years past the Division of Foods of the Bureau of Chemistry has examined many of the meat extracts and so-called meat juices. During the winter of 1905–6 a complete analysis of more than thirty meat preparations was made. While the work was in progress, several questions were raised which demanded further study and consequently delayed the publication of the results.

The object of the investigation was to determine the condition and quality of meat preparations, many of which are widely advertised and highly recommended for invalids. The need of standards for judging the merits of such preparations is evident, and the fact that complete analyses of American meat preparations are not available makes the publication of the results obtained desirable. The tentative standards for meat extracts and meat juices, peptones, and gelatin, as prepared by the Committee on Food Standards of the Association of Official Agricultural Chemists, are given under the appropriate captions.

DESCRIPTION OF SAMPLES.

The samples which were analyzed in this investigation were purchased on the retail market in the winter of 1905–6 and represent the market conditions prior to the passage of the meat-inspection act by Congress June 30, 1906, and the enforcement of the same by the Bureau of Animal Industry. It is well known that products of this class vary somewhat from year to year, and, moreover, different results may be obtained on the same sample by the application of different methods. As the same treatment was given to all of the preparations included in this report their relative values are fairly indicated. In connection with the descriptive table are given such comments as the manufacturers or agents of the various preparations offered when the analyses were submitted to them.

TABLE I.—*Description of samples analyzed.*

SOLID MEAT EXTRACT—(SEE TABLE II).

Serial number.	Name of preparation.	Manufacturer.
15867	"Rex" Brand Beef Extract	The Cudahy Packing Company, Omaha, Nebr.
15868	Liebig's Extract of Meat	Liebig's Extract of Meat Company, Antwerp, Belgium. (Agents, Corneille, David & Co., 120 Hudson street, New York, N. Y.)
15869	Armour's Extract of Beef	Armour and Company, Chicago, Ill.
16048	Extract of Beef Premier	Libby, McNeill and Libby, Chicago, Ill.
16049	Beef Extract	Swift and Company, Chicago, Ill.
16060	Beef Extract, Coin Special	G. H. Hammond Company, Chicago, Ill.

FLUID MEAT EXTRACTS—(SEE TABLE IV).

15964	Concentrated Fluid Beef Extract	Armour and Company, Chicago, Ill.
15965	Beef Juice	John Wyeth and Brother, Philadelphia, Pa.
15966	Meat Juice	Valentine's Meat Juice Company, Richmond, Va.
15977	Vigoral	Armour and Company, Chicago, Ill.
15979	"Rex" Fluid Beef Extract	The Cudahy Packing Company, Omaha, Nebr.
15990	Fluid Extract of Beef	Cibils Company, Importers, New York, N. Y.
15991	Fluid Beef Jelly	The Mosquera-Julia Food Company, Detroit, Mich. (Agents, Parke, Davis & Co.)

MISCELLANEOUS PREPARATIONS—(SEE TABLE IX).

15911	Bouillon Capsules	Royal Specialty Company, New York, N. Y.
15963	Bovril, Seasoned	Bovril (Ltd.), London, England. (Park and Tilford, agents, New York, N. Y.)
15976	Beef Jelly, Mosquera Extract of Beef.	The Mosquera-Julia Food Company, Detroit, Mich. (Agents, Parke, Davis & Co.)
16040	Essence of Beef	Brand and Company (Ltd.), Mayfair, Vauxhall, S. W. London. (Fougera Company, agents, New York N. Y.)
16044	Predigested Beef	H. K. Mulford Company, Philadelphia, Pa.
15870	Soluble Beef	Armour and Company, Chicago, Ill.
15908	Bovox Essence of Beef	The Bovox Company, Boston, Mass.
15909	Johnson's Fluid Beef	Bovril (Ltd.), Montreal, Canada.
15988	American Brand Extract of Beef	American Beef Extract Company, Boston, Mass.
15989	Bovinine Concentrated Beef	The Bovinine Company, 75 W. Houston street, New York.
16038	Essence of Mutton	The London Essence Company, London, England. (W. B. Hurd and Company, 18 Cedar street, New York, N. Y.)
16043	Liquid Food (extract of beef, mutton, and fruits).	Murdock Liquid Food Company, Boston, Mass.
15978	Maggi's Bouillon	The Maggi Company, Kempttal, Switzerland. (J. P. Smith and Company, agents, 90 Hudson street, New York, N. Y.)
16042	Peptonized Beef. Rose	P. B. Rose. (General agents, Chapman, Green and Company, Chicago, Ill.)
15910	Beef Extract and Vegetable Tablets	Armour and Company, Chicago, Ill.
16037	Leube-Rosenthal's Beef Solution	Ph. Rudisch. (Cheppe and Schur, agents, Third avenue and 60th street, New York, N. Y.)
16039	Malted Meat Extract of Beef	American Malted Meat Company, South Milwaukee, Wis.
16041	Beef Peptonoids	The Arlington Chemical Company, Yonkers, N. Y.

COMMENT BY MANUFACTURERS.

The analyses of the commercial products examined were referred to the manufacturers or their agents, and the following extracts from the replies received are submitted.

The letters addressed to the American Beef Extract Company, Boston, Mass.; American Malted Meat Company, South Milwaukee, Wis.; Cibils Company, New York City; W. B. Hurd and Company, 18 Cedar street, New York City, and to Chapman, Green and Company, Chicago, Ill., were returned unclaimed. The following manufacturers

replied, but offered no criticism of the analyses: The Bovinine Company, 75 West Houston street, New York City; the Murdock Liquid Food Company, Boston, Mass.; Fougera and Company, 90 Beekman street, New York City, and the Liebig's Extract of Meat Company.

From the following manufacturers no reply was received:

Swift and Company, Chicago, Ill.; G. H. Hammond Company, Chicago, Ill.; Cibils Company, New York City; Royalty Specialty Company, New York City; The Bovox Company, Boston, Mass.; The London Essence Company (W. B. Hurd and Company), 18 Cedar street, New York City; Ph. Rudisch (Cheppe and Schur, agents), Third avenue and Sixtieth street, New York; American Malted Meat Company, South Milwaukee, Wis.

THE ARLINGTON CHEMICAL COMPANY.

No. 16041.

The analysis submitted by you evidently refers to the preparation, Beef Peptonoids Powder, formerly manufactured by us, but which was superseded June 1, 1906, by an entirely different form, under the name of Dry Peptonoids (Soluble). This was done after several years' experimentation demonstrated that we could increase the nutrient value, improve the taste, and render the powder entirely soluble. The old form, Beef Peptonoids Powder, has been taken off the market and all stock in hands of the trade taken up.

Therefore we believe that the publication of an analysis of this obsolete preparation can be of no possible interest to anyone, and that the composition of the form now in use and on the market should be determined and published by you. * * *

We believe, in view of the facts as given herewith, that in justice to us, and in order that the object of the Bureau of Chemistry be accomplished, an analysis of the Dry Peptonoids (Soluble) should be made by you and published in accordance with the provisions of the act of Congress cited in your letter.

[In accordance with the request of The Arlington Chemical Company, the following analysis of the "Dry Peptonoids (Soluble)," as made by their chemist, December 15, 1906, is given in this connection:]

	Per cent.
Moisture	5.6
Nitrogenous compounds (N x 6.25)	39.5
Total carbohydrates, after inversion	46.7
Ether extract (fats and lipoids)	0.3
Mineral constituents (ash)	5.8
Insoluble material	1.0

Comment by authors.—The writer was informed that as the entire report represented the samples on the market in the winter of 1905–6 it would not be just to other manufacturers to bring the work up to date in one case alone.

ARMOUR AND COMPANY.

Nos. 15869, 15870, 15910, 15964, and 15967.

The results are very different from what we should expect, and from results which we have obtained in our experience with these products.

The most striking feature is the low results you report on kreatin and kreatinin. As a matter of fact we find that it makes a great difference which method is used in deter-

mining total kreatinin. The method we use in this laboratory is the modification of Folin's method as suggested by Grindley and Woods. From our experience we presume that the method you use is the same as that outlined in the proposed methods for the cooperative work on the sample of beef extract sent out June 3, 1907. Our results on this cooperative work, as well as our analyses of several other samples, give materially lower figures for total kreatinin [a] by the method furnished us by Mr. Cook in his letter of June 3 than by the method of Grindley and Woods.

We also note that the percentage of proteid [b] as determined in fluid extract of beef is not proportional to the proteid as determined in solid extract. Inasmuch as one is made from the other by mere solution in water, we are unable to find an explanation for this difference, assuming that both were determined by the same method. We note also that the total nitrogen in these two preparations is not proportional.

Among other features that we note we shall mention only the unusually high moisture in Soluble Beef. It is considerably higher than our records.

Comment by authors.—The fact that some of the results vary with the method used has already been discussed, and this is especially the case with kreatinin. As the same method was applied to all the samples reported, no injustice is done.

The percentage of moisture and total nitrogen in the solid and fluid extract are proportional, but the percentage of total proteids in the fluid extract is lower than in the solid extract. This, however, is compensated for by a correspondingly higher percentage of meat bases. This may be due to the failure of the tannin-salt reagent to precipitate all of the proteid, and consequently a higher meat base result is obtained.

BOVRIL LIMITED.

No. 15909.

We have to thank you for your favor of September 21, but we can not help thinking that there has been a misunderstanding somehow, for our standard for moisture and ash [c] in Johnston's Fluid Beef is 32 per cent and 19 per cent, respectively.

A careful analysis of the last three batches made has given—

	Moisture.	Ash.
No. 1	33.69	19.34
2	31.22	18.80
3	32.61	19.20

We are under the impression that the sample you have analyzed is a cordial and not the original Johnston's Fluid Beef. The latter is a paste standardized as above, whereas the cordial is a liquid prepared with a higher percentage of moisture for convenient use in saloons, etc.

Comment by authors.—The product reported under No. 15909 was labeled as "Johnson's Fluid Beef." Owing to the statement of the manufacturer, a new sample was obtained on the market and the moisture and ash determined again. This sample contained 38.62 per cent of water and 13.18 per cent of ash.

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[a] See Tables II, IV, and IX.
[b] See Tables III, V, and X.
[c] See Table IX, page 26.

The Cudahy Packing Company.

Nos. 15867 and 15979.

For your information we wish to say that the Extract of Beef we are now putting on the market is, in our estimation, a superior article to the preparation we were selling at that time, and we are having an analysis made of our present manufacture and will submit the figures to you as soon as completed.

Libby, McNeill and Libby.

No. 16048.

In reply to your favor of September 21, in reference to your analysis of our Premier Brand Extract of Beef, will state that we have carefully examined our analyses for an extended period and find that our determinations are not in accordance with your analysis. You, of course, recognize that in the making of this product there is sure to be considerable variation and we feel sure your Department does not expect each batch to be an exact duplicate of every other one. * * *

We have had our chemist analyze samples from our present stock and submit the following, which are the average of his determinations of the various samples analyzed—

	Per cent.		Per cent.
Moisture	19.54	Total nitrogen	7.66
Ash	27.80	Ether extract	.53
Sodium chlorid	11.32	Lactic acid	7.97
Proteid	13.12	Ammonia	.56
Meat bases	18.12	Undetermined	12.34
Total kreatinin	5.40		

Comment by authors.—An unsuccessful attempt was made to secure another sample of this product.

H. K. Mulford Company.

No. 16044.

A comparison of the results with analyses on record in our laboratory agree quite well in the main. * * * Some eighteen months ago we revised our label and literature on Predigested Beef in an effort to have our statements conservative and in accordance with the standards established through assay of the finished product.

Parke, Davis and Company.

Nos. 15976 and 15991.

Acknowledging the receipt of your two reports upon Mosquera Beef Jelly (Extract of Beef) and Mosquera Fluid Beef Jelly, we beg to say that we have no particular criticism to offer to the results as outlined any further than to say that they agree in a general way with the data which we have obtained and which have been obtained by others in the analysis of these two products. * * * You of course realize that the results obtained from the analysis of different samples of beef extract will vary, and the same is equally true of the results obtained by different operators. Furthermore, the results as expressed vary according to the method of assay employed, particularly as regards the interpretation placed upon the content of nitrogen.

* * * We presume to suggest that the estimation of a total acidity of beef extracts as lactic acid will be regarded by analytical chemists as somewhat of an innovation. This is certainly calculated to work some injustice in the case of our beef extracts, inasmuch as fruit acids are incorporated through the use of the pineapple juice employed in the process of manufacture.

May we ask, therefore, that you will incorporate in your final report some note to the effect that the total acids of the extract are calculated as lactic acid, and furthermore a statement that "Juice of partially ripened pineapples is employed as a digestant in the manufacture of Mosquera Beef Extract.[a] The high percentage of acidity is probably therefore accounted for by the acidity of the pineapple juice.

Comment by authors.—The points raised as to method of stating acidity are elucidated by table headings and context.

JAMES P. SMITH AND COMPANY.

No. 15978.

We have not imported the article labeled "Maggi Bouillon" since November, 1906, as under the advice of your Department we changed the label so that it read "Maggi Essence."

It is not a food product in the general acceptation of the term, but an essence which is added in very small quantities as an improver to insipid soups, weak bouillon, etc.

JOHN WYETH AND BROTHER.

No. 15965.

In comparing the results of your analysis with the figures obtained in our own laboratories, as well as with the analysis made some years since by Dr. Fresenius, of Wiesbaden, we are glad to say that in a general way the three analyses agree, particularly in view of the fact that doubtless the methods used in the different determinations have varied to some extent. The only appreciable difference we notice between your analysis and that of Fresenius is in the percentage of meat bases,[b] which in his analysis is reported as 14.33 per cent as against your 5.99 per cent, but we find that this is due to a difference in the factor employed, that used by Fresenius being 6.25, while you have used the now generally accepted factor 3.12 in calculating the meat bases. We have ourselves determined the meat bases as amounting to 8.26 per cent, by precipitating the total proteids with bromin, deducting the percentage of nitrogen which they contain from the total nitrogen and multiplying the difference by the factor 3.12.

MEAT EXTRACTS.

TENTATIVE STANDARDS.

The following standards were issued for criticism by the Committee on Food Standards of the Association of Official Agricultural Chemists, on November 19, 1906, but have never been officially promulgated by the Department.

SOLID MEAT EXTRACT.[c]

1. Meat extract is the product obtained by extracting meat with boiling water and concentrating the liquid portion by evaporation after the removal of fat, and contains not less than seventy-five (75) per cent of total solids, of which not over twenty-seven

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[a] Acidity of sample No. 15976 given in Table IX; No. 15991 in Table X.

[b] See Table X, page 27.

[c] Subsequent action by the Joint Committee on Food Standards, representing the Association of Official Agricultural Chemists and the Association of State and National Food and Dairy Departments has modified the standard to read "not less than 8 per cent is nitrogen," inserted the word "Fresh" before the word "Meat" in the first line, and added the words "and kreatinin" in the last line. These changes have not been officially promulgated.

(27) per cent is ash and not over twelve (12) per cent is sodium chlorid (calculated from the total chlorin present), not over six-tenths (0.6) per cent is fat, and not less than seven (7) per cent is nitrogen. The nitrogenous compounds contain not less than forty (40) per cent of meat bases and not less than ten (10) per cent of kreatin.

FLUID MEAT EXTRACT.

2. Fluid meat extract is identical with meat extract except that it is concentrated to a lower degree and contains not more than seventy-five (75) and not less than fifty (50) per cent of total solids.

In connection with these tentative standards, the following requisites for a meat extract given by Liebig [a] are of interest:

1. A good extract should contain no albumin and no fat (the latter not above 1.5 per cent).
2. The water content should not exceed 21 per cent.
3. About 60 per cent should be soluble in 80 per cent alcohol.
4. The nitrogen content should run from 8.5 to 9.5 per cent.
5. The ash should vary from 15 to 25 per cent, which, besides a little sodium chlorid, consists principally of phosphates.

METHODS OF PREPARATION.

Up to a few years ago the soup liquor obtained from meat which was parboiled in the process of preparing canned meat was entirely wasted, but this liquor is now extensively utilized in the manufacture of extracts and preparations of meat. In preparing canned meat pieces of meat are placed in iron baskets which are suspended in large tanks containing cold water. Steam is admitted and the meat heated about one-half hour (thirty to forty minutes). The liquor, which is the source of meat extracts, is pumped into triple-effect vacuum pans and heated at 160° F. for about four hours. Then the solution is transferred to a single-effect finishing kettle and heated eight hours until the water content approximates 22 per cent.

A first-grade extract of beef is prepared from beef alone and is usually sold in jars. An extract of the trimmed bones, to which considerable meat adheres, is also made. The trimmings include odds and ends of meat, muscle tissue, bone, etc., and the product is a second-grade article. In preparing this extract the bones are heated, not boiled, for thirty to forty minutes, and the liquor evaporated to the consistency of extract. The extract prepared from corned beef liquor constitutes another second-grade product. This extract has a high content of nitrates and sodium chlorid. In addition there is an extract prepared from pork and other meats, sold under the general term of meat extract. Mixtures of the various meat and bone extracts are often made. A fluid meat extract is usually a 50 per cent solution of a solid extract.

[a] Röttger, Lehrbuch der Nahrungsmittel-Chemie, p. 135.

Assuming that beef extract contains 21.7 per cent of water, there is obtained from 100 pounds of "soup liquor" 1.94 pounds of commercial meat extract.[a] These figures are high, as they are calculated from the total solids present in soup liquor. The manufacturers claim that 100 pounds of "soup liquor" will yield 1 pound of meat extract.

In speaking of the preparation of meat extracts, Charles R. Valentine[b] states that when raw meat is finely chopped and macerated in the same weight of cold distilled water and squeezed out, the water dissolves from 16 to 24 per cent of the weight of the dry flesh. If the water infusion is heated, the albumin of the flesh separates as a flocculent precipitate when the temperature of 133° F. is reached, and the red coloring matter of the blood, likewise albuminous, coagulates at 158° F. The infusion, or extract of flesh, from which the coagulated albumin has been strained, when evaporated at a gentle heat becomes darker in color. When it is dried there is obtained a brown, rather soft mass amounting to 12 or 13 per cent of the original flesh.

Valentine says it is not claimed that extract of meat is a food, but that it contains the extractive matter and salts of a large quantity of beef and possesses certain medicinal and dietetic properties. From about 32 pounds of lean beef, free from fat and bone, equal to 8 pounds of dry meat and 24 pounds of water, 1 pound of true extract of beef can be made. A good extract should always have an acid reaction, its color should be a characteristic yellowish brown, and it should have an agreeable meat-like odor and taste. It should be entirely soluble in cold water, and free from albumin, fat, and gelatin.

Solid Meat Extracts.

The percentage of nitrogen with its distribution in the various nitrogenous bodies is given in Tables II and III and throws much light on the quality of the extract. The meat products examined are divided into four classes, i. e., solid and fluid meat extracts, meat juices, based on the definitions of the standards committee, and miscellaneous preparations. Of the six solid meat extracts reported in Table II, several fall below the definition in one or two points. They, nevertheless, closely adhere to them in most respects, the percentage of nitrogen present in the form of total meat bases and kreatinin nitrogen being sufficiently high.

The figures in Table III are obtained by calculation from those in Table II, and represent the percentages of nitrogenous bodies present expressed both as per cent of total nitrogen and as per cent of sample. In order to obtain the nitrogenous bodies from the corresponding nitrogen figures the following factors were employed: For insoluble

[a] U. S. Dept. Agr., Bureau of Chemistry, Bul. 13, Part 10, p. 1390.
[b] J. Soc. Arts, 1897, *46* : 430.

and coagulable proteid, proteoses, and peptones the factor 6.25 was used. To obtain total meat bases, total kreatinin, and the meat bases other than kreatinin and xanthin, the factor 3.12 was employed. The xanthin factor used was 2.71 and the ammonia factor 1.2143.

Fluid Meat Extracts.

The analysis of these preparations is given in Tables IV and V. As was the case with the solid meat extracts, not all of the products included under Table IV correspond in every detail with the definition of the standards committee for fluid meat extracts. The solids according to the definition should run from 50 to 75 per cent. Several extracts in Tables IV and V are below the minimum figure. The price of some of these products is even greater than the price of meat extracts notwithstanding the fact that the water content is much higher.

TABLE II.—*Analysis of solid meat extracts.*

Serial No.	Moisture.	Mineral constituents.					Acidity.		Nitrogen as—									Ether extract.	Undetermined.	Sample.	
		Total ash.	Chlorin as sodium chlorid in ash.	Total phosphoric acid.	Organic phosphoric acid.	Inorganic phosphoric acid.	N/10 sodium hydroxid.	As lactic acid.	Total nitrogen.	Insoluble and coagulable.	Proteoses.	Peptones.	Total meat bases.	Kreatin and kreatinin.	Xanthin bases.	Meat bases other than kreatin and xanthin.	Ammonia.			Net weight.	Price.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*cc per gram.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Grams.*	*Cents.*
15867	26.50	24.06	8.54	2.29	0.35	1.94	6.67	6.01	7.30	0.32	1.65	1.57	3.56	0.87	0.38	2.31	0.20	1.30	8.66	55.8	45
15868	21.14	21.03	3.11	2.40	.61	1.79	9.04	8.13	9.07	.19	2.01	2.68	3.82	1.14	.03	2.65	.37	.94	5.89	57.8	45
15869	21.66	20.46	5.47	4.55	.49	4.06	9.35	8.42	7.66	.48	2.02	1.90	3.05	.75	.04	2.26	.21	.50	11.67	45.7	40
16048	21.86	30.92	18.32	2.53	.24	2.29	5.72	5.15	6.02	.29	.77	1.33	3.20	1.01	.11	2.08	.43	.53	16.11	131.4	53
16049	20.16	27.28	13.51	2.89	.18	2.71	4.61	4.15	6.60	.35	1.02	1.09	3.43	.81	.45	2.17	.71	.43	21.04	115.2	57
16060	12.39	31.68	13.25	3.19	.21	2.98	7.16	6.44	6.86	.06	.86	1.48	4.21	1.24	.52	2.45	.25	.43	20.61	119.9	60

TABLE III.—*Nitrogenous constituents of solid meat extracts (calculated from Table II).*

Serial No.	Nitrogenous bodies.								Nitrogenous bodies expressed in terms of total nitrogen.							
	Total proteids.[a]	Insoluble and coagulable proteid.	Proteoses.	Peptones.	Total meat bases.	Kreatin and kreatinin.	Xanthin bases.	Meat bases other than kreatin, kreatinin, and xanthin.	Ammonia.	Insoluble and coagulable proteid.	Proteoses.	Peptones.	Total meat bases.	Kreatin and kreatinin.	Xanthin bases.	Meat bases other than kreatin, kreatinin, and xanthin.	Ammonia.
	Per ct.	*Per cent.*	*Per ct.*	*Per ct.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per ct.*
15867	22.12	2.00	10.31	9.81	11.11	2.71	1.03	7.21	0.24	4.38	22.60	21.51	48.77	11.92	5.21	31.64	2.74
15868	30.50	1.19	12.56	16.75	11.92	3.56	.08	8.27	.45	2.09	22.16	29.55	42.12	12.57	.33	29.22	4.08
15869	27.51	3.00	12.63	11.88	9.52	2.34	.11	7.05	.26	6.27	26.37	24.80	39.82	9.79	.52	29.50	2.74
16048	14.93	1.81	4.81	8.31	9.98	3.15	.30	6.49	.52	4.82	12.79	22.09	53.16	16.78	1.83	34.55	7.14
16049	15.38	2.19	6.38	6.81	10.70	2.53	1.22	6.77	.86	5.30	15.45	16.52	51.97	12.27	6.82	32.88	10.76
16060	15.01	.38	5.38	9.25	13.14	3.87	1.41	7.64	.30	.87	12.54	21.57	61.37	18.08	7.58	35.71	3.64

[a] The sum of insoluble and coagulable proteids, proteoses, and peptones.

TABLE IV.—*Analysis of fluid meat extracts.*

Serial No.	Moisture.	Mineral constituents.					Acidity.		Nitrogen as—									Ether extract.	Undetermined.	Sample.	
		Total ash.	Chlorin as sodium chlorid in ash.	Total phosphoric acid.	Organic phosphoric acid.	Inorganic phosphoric acid.	N/10 sodium hydroxid.	As lactic acid.	Total nitrogen.	Insoluble and coagulable proteid.	Proteoses.	Peptones.	Total meat bases.	Kreatin and kreatinin.	Xanthin bases.	Meat bases other than kreatin and xanthin.	Ammonia.			Net weight.	Price.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*cc per gram.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Grams.*	*Cents.*
15964	57.75	17.23	8.27	2.32	0.26	2.06	3.46	3.11	2.85	0.04	0.34	0.70	1.66	0.38	0.23	1.05	0.11	0.09	9.75	105.7	40
15965	58.84	16.21	6.71	3.27	.04	3.23	4.35	3.92	3.15	*a* .46	.10	.47	1.92	.26	.26	1.40	.20	.23	8.12	68.6	50
15966	57.64	10.26	1.77	3.41	.45	2.96	5.04	4.53	3.06	.03	.10	.77	1.94	.35	.22	1.37	.22	.50	15.12	69.7	75
15977	49.94	15.91	7.02	3.29	.46	2.83	5.29	4.76	3.87	*a* .29	.69	.74	2.02	.48	.17	1.37	.13	.04	12.14	63.5	35
15979	55.99	16.99	8.48	2.48	.38	2.10	5.51	4.92	3.95	*b* .17	.54	.41	2.63	.80	.04	1.79	.20	.05	6.60	73.7	35
15990	64.63	16.13	11.38	.95	.14	.81	2.70	2.43	3.18	*c* .31	.44	.89	1.36	.50	.09	.77	.18	.06	2.04	102.2	45
15991	68.97	13.85	10.05	.80	.18	.62	2.45	2.20	2.41	*a* .08	.31	.91	.98	.26	.08	.64	.13	.09	3.54	127.4	50

[a] All coagulable. [b] Largely insoluble. [c] Partly insoluble.

TABLE V.—*Nitrogenous constituents of fluid meat extracts (calculated from Table IV).*

Serial No.	Nitrogenous bodies.									Nitrogenous bodies expressed in terms of total nitrogen.							
	Total proteids.[a]	Insoluble and coagulable proteid.	Proteoses.	Peptones.	Total meat bases.	Kreatin and kreatinin.	Xanthin bases.	Meat bases other than kreatin, kreatinin, and xanthin.	Ammonia.	Insoluble and coagulable.	Proteoses.	Peptones.	Total meat bases.	Kreatin and kreatinin.	Xanthin bases.	Meat bases other than kreatin, kreatinin, and xanthin.	Ammonia.
	Per ct.	*Per cent.*	*Per ct.*	*Per ct.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per ct.*
15964	6.76	0.25	2.13	4.38	5.18	1.19	0.62	3.28	0.13	1.40	11.93	24.56	58.25	13.33	8.07	36.84	3.86
15965	6.45	2.88	.63	2.94	5.99	.81	.71	4.37	.24	14.60	3.17	14.92	60.95	8.25	8.25	44.44	6.35
15966	5.63	.19	.63	4.81	6.05	1.09	.60	4.27	.27	.98	3.27	25.16	63.40	11.44	7.19	44.47	7.19
15977	10.75	1.81	4.31	4.63	6.30	1.50	.46	4.27	.16	7.49	17.83	19.12	52.20	12.40	4.39	35.40	3.36
15979	7.00	1.06	3.38	2.56	8.21	2.50	.11	5.58	.24	4.30	13.67	10.38	66.58	20.25	1.01	45.32	5.06
15990	10.25	1.94	2.75	5.56	4.24	1.56	.24	2.40	.22	9.75	13.84	27.99	42.77	15.72	2.83	24.21	5.66
15991	8.13	.50	1.94	5.69	3.06	.81	.22	2.00	.16	3.32	12.86	37.76	40.66	10.79	3.32	26.56	5.39

[a] The sum of insoluble and coagulable proteids, proteoses, and peptones.

MEAT JUICES.

Tentative Standard.

Meat juice is defined by the standards committee of the Association of Official Agricultural Chemists as the fluid portion of muscle fiber obtained by pressure or otherwise, and may be concentrated by evaporation at a temperature below the coagulating point of the soluble proteids. The solids contain not more than fifteen (15) per cent of ash, not more than two and five-tenths (2.5) per cent of sodium chlorid (calculated from the total chlorin present), not more than four (4) nor less than two (2) per cent of phosphoric acid (P_2O_5), and not less than twelve (12) per cent of nitrogen. The nitrogenous bodies contain not less than thirty-five (35) per cent of coagulable proteids and not more than forty (40) per cent of meat bases.

Discussion of Results.

Several of the preparations included in miscellaneous preparations (Table IX) were advertised as meat juices. During the autumn of 1906 several samples of meat juice were prepared in the laboratory. Large samples of round and chuck beef were made practically fat free, cut into small pieces with a knife, and one sample of each pressed in the cold through cotton bags in a glycerin cylinder press. Another sample of each was heated at 60° C. in large jars for several hours, then pressed as above described. The analyses of these four samples and of several other samples of meat juices prepared in various ways in the laboratory are given in Table VI.

A meat juice naturally varies according to its mode of preparation, and more juice is obtained by heating the meat to 60° C. than by extracting in the cold. In the case of the samples made in the laboratory practically one-half the nitrogen is in the form of coagulable proteid nitrogen. In several cases a considerably larger portion is in that form.

A meat juice is characterized by a high content of coagulable proteids and a low content of meat bases. Of the so-called commercial meat juices in Table IX none shows any appreciable amount of coagulable proteid. They are, therefore, not correctly designated by the name meat juice and their nutritive value is misrepresented by such designation. It appears impracticable to prepare a true meat juice for market, as the temperature necessary for the preservation of food products in hermetically sealed packages coagulates the proteids and changes the nature of the product. The fact that when these higher forms of nitrogenous bodies are removed the valuable nutritive principles of the juice are lost must be recognized, and a product so altered should not be designated as a meat juice.

In muscle tissue there is found approximately 75 per cent of water. Of the 100 parts of nitrogen in beef, 75 parts consist of proteid matter insoluble in water; 10 parts consist of water-soluble proteid, and 12.5 parts of extractives, which are also water soluble. Unfortunately in making these analyses the total kreatinin was not determined. As before stated, all of these juices are characterized by a large amount of coagulable proteid, while the percentage of the other constituents present seems to vary with the water content. The small amount of sodium chlorid in the ash is noticeable, and the amount of nitrogen present in the form of albumoses and peptones is small, as would be expected in a true meat juice. It is evident from Table VI that there is considerable water-soluble amido nitrogen present in the juice of meats.

TABLE VI.—*Meat juices prepared in laboratory.*

Serial No.	Preparation of juice.	Composition of sample.					
		Water in juice.	Ash.	Chlorin as sodium chlorid in ash.	Phosphoric acid (P_2O_5).	Ether extract.	Acidity as lactic acid.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17091	Round beef, cold pressed	85.76	1.53	0.12	0.37	0.27	0.27
17092	Chuck beef, cold pressed	86.85	1.86	.20	.31	.30	.32
17091	Round beef pressed at 60° C	90.65	1.36	.15	.36	.19	.15
17092	Chuck beef pressed at 60° C	91.90	1.29	.19	.29	.64	.20
19766	Juice from beef chuck at 60° C	89.56	1.27	.16	.37	.....	.....
19767	Juice pressed from sirloin steak and water	91.10	1.40	.12	.18	.....	.....
19785	Juice extracted from sirloin steak by cold pressure	96.13	.46	.05	.14	.....	.....
19786	Juice extracted from beef chuck by cold pressure	96.58	.43	.05	.11	.....	.....
19787	Juice extracted from beef chuck by cold pressure after 6 hours at 60°–100° C	98.11	.39	.05	.12	.....	.....

Serial No.	Preparation of juice.	Composition of sample.						
		Total nitrogen.	Insoluble nitrogen.	Coagulable nitrogen.	Proteose nitrogen.	Peptone nitrogen.	Amido nitrogen.	Undetermined matter.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
17091	Round beef, cold pressed	2.08	0.16	1.37	0.06	0.16	0.33	0.47
17092	Chuck beef, cold pressed	1.74	.29	.98	.07	.11	.29	1.03
17091	Round beef pressed at 60° C	1.16	.68		.04	.01	.43	1.90
17092	Chuck beef pressed at 60° C	1.09	.12	.41	.07	.21	.27	.40
19766	Juice from beef chuck at 60° C	1.09	.49		.42	.....	.18	2.92
19767	Juice pressed from sirloin steak and water	1.18	.54		.20	.18	.26	.94
19785	Juice extracted from sirloin steak by cold pressure	.48	.34		Trace.	None.	.14	.85
19786	Juice extracted from beef chuck by cold pressure	.43	.34		Trace.	None.	.09	.59
19787	Juice extracted from beef chuck by cold pressure after 6 hours at 60°–100° C	.24	0		Trace.	.12	.08	.25

TABLE VI.—*Meat juices prepared in laboratory*—Continued.

Serial No.	Preparation of juice.	Results in terms of total nitrogen.					Nitrogenous bodies.				
		Insoluble proteid.	Coagulable proteid.	Albumoses.	Peptones.	Amido bodies.	Insoluble proteid.	Coagulable proteid.	Proteoses.	Peptones.	Amido bodies.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
17091	Round beef, cold pressed	7.69	65.87	2.88	7.69	15.87	1.00	8.56	0.38	1.00	1.03
17092	Chuck beef, cold pressed	16.66	56.32	4.02	6.32	16.66	1.81	6.13	.44	.69	.90
17091	Round beef pressed at 60° C	58.62		3.45	.86	37.07	4.25		.25	.06	1.34
17092	Chuck beef pressed at 60° C	11.01	37.61	6.42	19.26	24.77	.75	2.56	.44	1.31	.84
19766	Juice from beef chuck at 60° C	44.95		38.53	.....	16.51	3.06		2.63	.....	.56
19767	Juice pressed from sirloin steak and water	45.76		16.95	15.25	22.03	3.38		1.25	1.13	.81
19785	Juice extracted from sirloin steak by cold pressure	70.83		.....	.....	29.17	2.13		Trace.	None.	.44
19786	Juice extracted from beef chuck by cold pressure	79.07		.....	.....	20.93	2.13		Trace.	None.	.28
19787	Juice extracted from beef chuck by cold pressure after 6 hours at 60°–100° C.	0		.....	50.00	33.33	0		Trace.	.75	.25

YEAST EXTRACTS.

MANUFACTURE AND USE OF YEAST PREPARATIONS.

Yeast on hydrolysis yields extractives which are similar to those obtained from meat. For many years yeast extracts have appeared on the market, especially in Germany, and have also been mixed with and used to adulterate meat extracts. Such products are now manufactured in this country to a limited extent. The water extract or infusion of yeast, when evaporated in the open-kettle process, darkens and looks like an extract of meat. Caramel is sometimes added to further deepen the color. When the process of evaporation is allowed to go too far, a bitter taste appears, which is due to the peptones formed, and it is claimed this may be removed by washing with water and dilute ammonia solution. In general the preparation of an extract of yeast is similar to that of an extract of meat. In an extract of yeast the higher nitrogen forms are more abundant than in meat extract. Two samples of yeast extract examined contained 5.68 and 5.67 per cent of total nitrogen. In regard to their stimulating effect and general action on the body the two extracts (meat and yeast) are practically identical according to Wintgen,[a] and their value as a proteid sparer depends only in part on their nitrogen content.

[a] Abs. Pharm. Ztg., 1905, *50*:432.

Methods of Detection.

Searl[a] suggests as a method for detecting yeast products added to meat preparations, that a solution of the extract be boiled one or two minutes with a modified Fehling's solution. In the presence of yeast extract a bluish-white precipitate is obtained. Arnold and Mentzel[b] claim that a slight bluish-white precipitate is given even with pure meat extracts, but by experience an analyst learns to detect by this method the presence of about 20 per cent of yeast extract in meat preparations. Micko[c] suggests the determination of kreatin and xanthin bodies as a means of determining the nature of the extract. Wintgen[d] states that the filtrate from the zinc sulphate precipitate obtained in the determination of albumoses is entirely clear in the case of meat extracts, but somewhat turbid with yeast extracts. This he finds to be true even when the best S. & S. filter paper is employed. By this method the authors could detect from 20 to 30 per cent of added yeast extract.

E. Baur and H. Barschall[e] have applied the colorimetric test, as outlined by Folin, for kreatinin to meat and yeast extracts. They find no kreatin or kreatinin in yeast extracts and base a distinction between the two on this test. Salkowski[f] has studied the various carbohydrates of yeast and gives several tests for yeast gum.

The most reliable test is unquestionably the determination of kreatin. A yeast extract contains no kreatin and in a typical meat extract there is found from 10 to 20 per cent of the total nitrogen in the form of kreatin and kreatinin. The distribution of the various xanthin bases also is different in the two kinds of extracts; in meat extracts, according to Micko,[g] xanthin and hypoxanthin predominate, while in yeast extracts adenin and guanin predominate.

Result of Tests.

A test for yeast extracts consisting in boiling the samples for one or two minutes with an unmodified Fehling's solution was tried. Four samples were tested with the following results:

	Color of precipitate.
A. Meat extract	Very deep violet color.
B. Yeast extract	Very deep green color.
C. 50 per cent yeast and 50 per cent meat extract	Intermediate color.
D. 25 per cent yeast and 75 per cent meat extract	Violet color, not as strong as A.

This test is of value as a qualitative and a confirmatory test for yeast extracts in the presence of meat extracts.

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[a] Pharm. J., 1903, *71*:516 and 704; 1904, *72*:86.
[b] Pharm. Ztg., 1904, *49*:176.
[c] Zts. Nahr. Genussm., 1902, *5*:193; 1903, *6*:781.
[d] Arch. Pharm., 1904, *242*:537.
[e] Arb. kaiserl. Gesundheitsamte, 1906, *24*:562.
[f] Ber. d. chem. Ges., 1894, *27*:499.
[g] Loc. cit.

The method of Searl for the detection of yeast extract by the use of a modified Fehling's solution was also tested. The method is as follows:

Prepare a modified Fehling's solution by dissolving 200 grains of copper sulphate and 250 grains of neutral tartrate of sodium in 4 ounces of water. Add to this 250 grains of sodium hydroxid dissolved in 4 ounces of water. Dissolve 10 grains of the sample to be examined in 1.5 ounces of water, add to this one-half volume of the above solution and boil for one or two minutes. With genuine meat extract no precipitate is given. When yeast extract is present a curdy, bluish-white precipitate is formed.

This method was tested on a sample of meat extract, a yeast extract, a 50 per cent solution of yeast and meat extract, and a solution containing 20 per cent of yeast and 80 per cent of meat extract. In the case of the meat extract a very fine precipitate was obtained. In the three cases where yeast extract was present a flocky, bluish-white precipitate was formed. It is evident from these results that the presence of 20 per cent of yeast extract in meat mixtures may be detected by this method.

Searl also gives a modification to be applied when doubtful results are obtained by the original method. In such cases 3 to 6 grams (50 to 100 grains) of the sample are dissolved in from 4 to 8 cc (1 to 2 drams) of water. Alcohol is added to precipitate the proteid matter, the solution is thoroughly shaken, and filtered. The residue is dissolved in 45 cc (1.5 ounces) of water, filtered if necessary, and the usual method applied.

This modification was tried on 10 and 20 per cent mixtures of yeast extract, but the results obtained were not satisfactory, and it is doubtful if less than 20 per cent of yeast extract can be detected in the presence of meat extract by this method.

Another test is described by Wintgen,[a] who claims that the zinc sulphate filtrate in the case of meat extracts is clear, but with yeast extracts it is turbid. This was found to be the case, as the following results show:

	Zinc sulphate filtrate.
A. Meat extract	Clear.
B. Yeast extract	Cloudy.
C. 50 per cent yeast and 50 per cent meat extract	Cloudy.
D. 25 per cent yeast and 75 per cent meat extract	Cloudy.

The solutions of these extracts, or mixtures, were saturated with chemically pure zinc sulphate after adding two drops of strong sulphuric acid. The solutions stood over night and the filtrates were examined in the morning. The only clear filtrate obtained was that from meat extract alone.

The most important test for determining the nature of an extract, whether meat or yeast, is the determination of kreatin and kreatinin. This test, which has been used in the Bureau of Chemistry for two or

[a] Arch. Pharm., 1904, *242*:537.

three years and found to be of great value, was perhaps first applied by Micko.[a] As before stated, yeast extracts contain no kreatin or kreatinin, while in meat extracts these two bodies are present in considerable amounts.

Some experiments on meat extract, yeast extract, and mixtures of the two were tried with satisfactory results, using the Folin[b] colorimetric method. In determining the kreatinin by this method in the presence of yeast extract, slightly higher results are obtained than when yeast extract is not present. When the kreatin and kreatinin are determined together (after dehydrolysis) in a sample of meat extract the presence of yeast extract does not seem to affect the results. In the case of the yeast extract no kreatin or kreatinin was found, as is shown in Tables VII and VIII.

TABLE VII.—*Kreatinin in meat and yeast extracts.*

No.	Description of sample.	Weight of sample.	Kreatinin.		Kreatinin calculated to meat extract used.	Increase of kreatinin due to presence of yeast extract.
			Weight.	Per cent.		
		Grams.	*Mg.*		*Per cent.*	*Per cent.*
1	Meat extract	0.2660	8.804	3.39	3.39	0
		.2663	8.804	3.31	3.31	
	Average			3.35	3.35	
2	Yeast extract	.4800	0	0	0	0
3	Mixture—50 per cent meat and 50 per cent yeast extract	.4154	7.788	1.87	3.75	
		.3756	7.013	1.87	3.75	0.40
	Average			1.87	3.75	
4	Mixture—75 per cent meat and 25 per cent yeast extract	.2638	8.437	3.19	4.25	
		.3030	7.941	2.62	3.49	.52
	Average			2.91	3.87	

TABLE VIII.—*Total kreatinin (including kreatin converted to kreatinin) in meat and yeast extracts.*

No.	Description of sample.	Weight of sample.	Kreatinin.		Kreatinin calculated to meat extract used.	Increase of kreatinin due to presence of yeast extract.	Kreatin calculated as kreatinin (by difference).
			Weight	Per cent.			
		Grams.	*Mg.*		*Per cent.*	*Per cent.*	*Per cent.*
1	Meat extract	0.2210	11.571	5.24	5.24	0	4.92—3.35
		.2144	9.870	4.60	4.60		=1.57
	Average			4.92	4.92		
2	Yeast extract	.5250	0	0	0	0	0
3	Mixture—50 per cent meat and 50 per cent yeast extract	.4378	11.571	2.64	5.29		5.05—3.75
		.4020	9.691	2.41	4.82	0.13	=1.30
	Average			2.53	5.05		
4	Mixture—75 per cent meat and 25 per cent yeast extract	.3554	15.577	4.38	5.85		5.05—3.87
		.3255	10.385	3.19	4.25	.13	=1.18
	Average			3.79	5.05		

[a] Loc. cit.

[b] Zts. physiol. Chem., 1904, *41*: 223.

MISCELLANEOUS PREPARATIONS.

Classification.

In Tables IX and X are reported all commercial samples examined which do not fall under either Table II or Table IV. No samples were found to comply with the definition for meat juice, nor were any peptones of American manufacture examined. The well-known German albumose and peptone powders, somatose and Witte's peptone, seem to answer the definition of peptones. A class of products consisting largely of albumoses and peptones under the general name of "atmid" or steam products is on the market. Another class of albumose and peptone preparations is prepared by chemically treating lean meat with acid and pepsin, by means of which all the fibrin, albumin, and gelatin are rendered soluble after being digested in water at a temperature of 100° F.

In this connection attention may be called to the crab extracts which have recently appeared in the German market. Ackermann and Kutscher[a] describe and present the analysis of an extract prepared from the flesh of crustaceans. This product has appeared on the market in Germany under the names "Krebsextract," "Krebsbutter," and "Krabbenextract." Extracts of this class do not repay the outlay necessary for their preparation. The usual method employed in manufacturing a meat extract was used. The nitrogen bodies were separated by the Steudel-Kutscher treatment with tannin, baryta, and lead. No kreatin or kreatinin was found, but an abundance of leucin, tyrosin, arginin, and lysin. Several of the constituents of this extract have been isolated and identified. Other extracts are prepared from fish, shrimps, clams, anchovies, etc., but are not of any great commercial importance.

The various extracts, juices, and powders included in Tables IX and X under "Miscellaneous preparations" are grouped according to the following classification: Class I, includes extracts with high total kreatinin (approaching 10 per cent) and a total meat base content of 40 per cent. The proteose and peptone nitrogen should run from 30 to 50 per cent. Products in Class II have a proteose and peptone nitrogen content above 50 per cent. They are low in both kreatinin and meat bases. Class III includes preparations that are low in proteose and peptone nitrogen and in kreatinin, but high in meat bases. Class IV includes extracts that are high in insoluble and coagulable proteid. The last four extracts are included in the fourth class. Extract marked No. 15910 resembles those of Class I and the extract marked No. 16037 those of Class II, but in both cases the insoluble and coagulable proteid figures are high. Several meat powders are included in Table VII. The number of such

[a] Zts. Nahr. Genussm., 1907, *13*.180, 610, 613.

products is far less numerous than the solid and fluid extracts. These products consist largely, if not entirely, of albumoses and peptones in addition to some insoluble proteid matter. The amount of insoluble and coagulable proteids is relatively small in most of the samples examined and the balance of the nitrogen is distributed between the proteoses, peptones, and meat bases. The relative amount of these nitrogenous bodies present depends on the method of manufacture and extent of the hydration to which they are subjected. The net weights, as well as the retail prices of the extracts purchased, are interesting and are given in Tables II, IV and IX.

Discussion of Results.

In several of these preparations but a small amount of meat extractives or bases is found. The amount of kreatin and kreatinin is negative in several cases, showing that the products in question were not made by the evaporation of an infusion of meat. The total nitrogen is extremely low in a number of instances, falling to 0.42 per cent in sample 16044. The stimulating value of the amido acids and the nutritive value of the higher forms of nitrogen must be exceedingly small in these cases. This same sample (16044) contains 91.69 per cent of water and retails for $1 per bottle of 477 grams. Another sample, 15989, retailing for 60 cents a bottle of 179 grams, is evidently largely an artificial product and on applying the method for the determination of organic phosphorus the sample did not appear to resemble a beef juice or extract. This sample contains but 2.36 per cent total nitrogen, of which only 3.81 per cent is in the form of meat bases; kreatinin is lacking, the insoluble residue is relatively large, and alcohol is present.

TABLE IX.—*Miscellaneous preparations (meat extracts, juices, and powders).*

Serial No.	Water.	Mineral constituents.					Acidity.		Nitrogen as—									Ether extract.	Undetermined.	Sample.	
		Total ash.	Chlorin as sodium chlorid in ash.	Total phosphoric acid.	Organic phosphoric acid.	Inorganic phosphoric acid.	N/10 sodium hydroxid.	As lactic acid.	Total nitrogen.	Insoluble and coagulable proteid.	Proteoses.	Peptones.	Total meat bases.	Kreatin and kreatinin.	Xanthin bases.	Meat bases other than kreatin, kreatinin, and xanthin.	Ammonia.			Net weight.	Price.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*cc per gram.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*Gms.*	*Dolls.*
15911	14.75	39.75	29.72	2.50	.....	.....	6.44	5.80	5.93	*a* 0.33	2.04	1.18	2.22	0.46	0.13	1.63	0.16	0.73	9.66	45.0	0.30
15963	43.39	16.09	8.73	2.26	.25	2.01	4.30	3.87	5.62	*b* 1.21	1.68	.64	1.93	.51	.16	1.26	.16	.56	7.82	110.5	.40
15976	27.82	17.31	8.39	2.80	.34	2.46	8.37	7.53	7.83	*a* .19	1.96	2.43	2.96	.58	.05	2.33	.29	.15	8.97	54.7	.45
16040	90.93	1.34	.09	.48	.11	.37	.98	.88	1.28	.03	.60	.18	.43	.11	.01	.31	.04	.51	— .12	87.2	.75
16044	91.69	.18	.01	.04	.01	.03	1.06	.96	.42	.01	.03	.15	.22	.02	.01	.19	.01	1.11	4.17	477.4	1.00
15870	30.15	14.55	5.21	2.39	.47	1.92	6.07	5.46	8.41	*a* .51	3.15	2.38	2.14	.42	.22	1.50	.23	.32	4.80	48.1	.45
15908	65.77	17.29	9.73	.88	.25	.63	3.23	2.91	3.71	.03	1.15	1.47	.89	.05	.01	.83	.17	.12	—5.65	182.9	.50
15909	47.22	9.80	4.37	.59	.19	.40	5.40	4.86	6.57	*b* .21	1.72	2.15	1.24	.20	.18	.86	.25	.48	1.72	120.5	.50
15988	27.54	34.73	24.73	2.53	1.10	1.43	6.56	5.91	5.63	*b* .29	1.47	2.51	1.15	.....	.03	1.12	.21	.62	.65	44.7	.35
15989	80.40	1.55	1.05	.09	.04	.05	1.36	1.22	2.36	*c* .54	1.66	.06	.09	None.	.03	.06	.01	.76	1.64	179.2	.60
16038	82.03	2.25	.18	.82	.08	.74	1.80	1.62	2.61	*c* .11	1.12	.69	.57	.17	.04	.36	.12	.12	.05	113.6	.75
16043	86.09	.65	.20	.10	.03	.07	1.35	1.21	1.84	*d* .31	.05	1.35	.08	None.	.03	.05	.05	.57	.48	170.6	.50
15978	56.56	21.94	17.53	1.04	.06	.98	4.56	4.10	2.76	.02	.15	.17	1.87	.07	.04	1.76	.55	.12	8.65	123.9	.50
16042	45.13	3.52	1.63	.43	.04	.39	2.31	2.08	6.98	*b* .22	.83	2.50	3.17	.07	.10	3.00	.26	1.11	15.75	233.5	1.00
15910	22.29	23.66	18.14	1.82	.....	.....	5.29	4.76	4.10	*b* 1.69	.69	.64	1.01	.15	.16	.70	.07	.43	26.76	62.8	.25
16037	72.68	3.91	1.84	.60	.09	.51	2.82	2.54	3.13	*b* 1.58	.49	.51	.43	.08	.01	.34	.12	2.48	.77	209.0	.60
16039	8.61	7.87	3.48	.75	.20	.56	.93	.84	2.02	*d* 1.23	.24	.10	.45	Trace.	.02	.43	0	2.97	68.49	129.3	.50
16041	5.72	5.63	.40	1.43	.42	1.01	.39	.35	4.12	*d* 3.23	.50	0	.39	Trace.	.04	.35	0	1.95	61.81	166.1	1.00

a Largely coagulable. *b* Largely insoluble. *c* All coagulable. *d* Partly insoluble.

TABLE X.—*Nitrogenous constituents of miscellaneous preparations.*

Serial No.	Nitrogenous bodies.									Nitrogenous bodies expressed in terms of total nitrogen.							
	Total proteids.[a]	Insoluble and coagulable proteids.	Proteoses.	Peptones.	Total meat bases.	Kreatin and kreatinin.	Xanthin bases.	Meat bases other than kreatin, kreatinin, and xanthin.	Ammonia.	Insoluble and coagulable proteids	Proteoses.	Peptones.	Total meat bases.	Kreatin and kreatinin.	Xanthin bases.	Meat bases other than kreatin, kreatinin, and xanthin.	Ammonia.
	Per ct.	*Per cent.*	*Per ct.*	*Per ct.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per ct.*
15911	22.19	2.06	12.75	7.38	6.93	1.44	0.35	5.09	0.19	5.56	34.40	19.90	37.44	7.76	2.19	27.49	2.70
15963	22.06	7.56	10.50	4.00	6.02	1.59	.43	3.93	.19	21.53	29.89	11.39	34.34	9.07	2.85	22.42	2.85
15976	28.63	1.19	12.25	15.19	9.24	1.81	.14	7.27	.35	2.43	25.03	31.03	37.80	7.41	.64	29.76	3.70
16040	5.07	.19	3.75	1.13	1.34	.34	.03	.97	.05	2.34	46.88	14.06	33.59	8.59	.78	24.22	3.13
CLASS II.																	
16044	1.19	.06	.19	.94	.69	.06	.03	.59	.01	2.38	7.14	35.71	52.38	4.76	2.38	45.24	2.38
15870	37.76	3.19	19.69	14.88	6.68	1.31	.60	4.68	.28	6.06	37.46	28.30	25.45	4.99	2.62	17.84	2.73
15908	16.57	.19	7.19	9.19	2.78	.16	.03	2.59	.21	.81	31.00	39.62	23.99	1.35	.27	22.37	4.58
15909	31.75	7.56	10.75	13.44	3.87	.62	.49	2.68	.30	18.42	26.18	32.72	18.87	3.04	2.74	13.09	3.81
15988	26.69	1.81	9.19	15.69	3.59	.....	.08	3.49	.25	5.15	26.11	44.58	20.43	.....	.53	19.89	3.73
15989	14.14	3.38	10.38	.38	.28	None.	.08	.19	.01	22.88	70.34	2.54	3.81	None.	1.27	2.54	.42
16038	12.00	.69	7.00	4.31	1.78	.53	.11	1.12	.15	4.21	42.91	26.44	21.84	6.51	1.53	13.79	4.60
16043	10.69	1.94	.31	8.44	.25	None.	.08	.16	.06	16.85	2.72	73.37	4.35	None.	1.63	2.72	2.72
CLASS III.																	
15978	2.13	.13	.94	1.06	5.83	.22	.11	5.49	.67	.72	5.43	6.16	67.75	2.54	1.45	63.77	19.93
16042	22.20	1.38	5.19	15.63	9.89	.22	.27	9.36	.32	3.15	11.89	35.82	45.42	1.00	1.43	42.98	3.72
CLASS IV.																	
15910	18.87	10.56	4.31	4.00	3.15	.47	.43	2.18	.03	41.22	16.83	15.61	24.63	3.66	3.90	17.07	1.71
16037	16.13	9.88	3.06	3.19	1.34	.25	.03	1.06	.15	50.48	15.65	16.29	13.74	2.56	.32	10.86	3.83
16039	9.82	7.69	1.50	.63	1.40	Trace.	.05	1.34	.00	60.89	11.88	4.95	22.28	Trace.	.99	21.29	.....
16041	23.32	20.19	3.13	.00	1.22	Trace.	.11	1.09	.00	78.40	12.14	.....	9.47	Trace.	.97	8.50	.....

[a] The sum of insoluble and coagulable proteids, proteoses, and peptones.

METHODS OF ANALYSIS AND THEIR DISCUSSION.

One of the great obstacles in the way of a thorough and careful study of proteids is the unsatisfactory condition of the analytical methods. Many of the variations in results which have appeared are undoubtedly due to faulty methods. Another serious source of error in this line of work lies in the fact that different methods are used by different analysts and the results are not comparable. For instance, copper oxid, phosphotungstic acid, tannic acid and salt, and other reagents, are used by various workers to precipitate the higher amido bodies and separate them from the simpler amido bodies. That the precipitating power of these reagents is not the same is well known. For determining acid and alkali albumins, insoluble proteid, and coagulable proteid, the methods give only approximate results, those for the determination of several of the individual bodies, such as kreatin, kreatinin, and ammonia, being in a much more satisfactory condition.

PREPARATION OF SAMPLE.

In the case of liquid and semiliquid preparations the bottle should be thoroughly shaken and great care taken to see that the solution is complete. Pasty and solid extracts or powders should be removed from the container and thoroughly mixed before sampling. A very convenient method is to dissolve a weighed sample in a measured quantity of water and run this out of a burette as needed. This solution should be kept cold and the determinations started without delay.

MOISTURE.

Moisture was determined in the various preparations examined by drying the sample over night in a water-jacketed drying oven. In the case of solid meat extracts approximately 3 grams of the sample were used, for fluid extracts, 10 to 12 grams, and for meat powders, 2 grams.

ASH.

The ash content of the commercial samples is seen to be surprisingly high in many cases. (See Tables II, IV, and IX.) This is due to the fact that sodium chlorid is present in meat extracts in varying and often excessive quantities. Especial attention is called to the large percentage of sodium chlorid present in several of the samples examined. The figures reported in the tables are obtained by calculating the total chlorin to sodium chlorid.

The ash was determined by the official method [a] and the sodium chlorid in the ash by the following procedure:

Dissolve the ash sample with nitric acid and make up to volume in a 200-cc flask. Use 20 per cent, or any convenient aliquot, for titration with sulpho-cyanid according to the Volhard method.

[a] U. S. Dept. Agr., Bureau of Chemistry, Bul. 107, p. 38.

A small amount of sodium chlorid is present in meat, and as much as 12 per cent is permitted by the tentative standard for meat extract, but the presence of 25 to 30 per cent is excessive and should be regarded as an adulteration.

From 0.8 to 1.8 per cent of meat is mineral matter, and calculated to water-free substance this amounts to from 2.3 to 7.5 per cent. The average composition of the ash of meat, according to König,[a] is as follows:

	Per cent.		Per cent.
Potassium	37.04	Phosphoric acid	41.20
Sodium	10.14	Sulphuric acid	0.98
Calcium	2.42	Chlorin	4.66
Magnesium	3.23	Silica	0.69
Oxid of iron	0.44		

Jolly[b] gives some very interesting figures showing the various combinations of phosphoric acid found in the muscles and tendons of calves and oxen, and the metabolism of the various mineral salts is fully discussed by Albu and Neuberg.[c] The analyses of the ash of several samples of meat juice prepared in the laboratory are given in Table XI.

TABLE XI.—*Analyses of ash of meat juices.*

Serial No.	Substance.	Chlorin as sodium chlorid.	Composition of salt-free ash.						
			Insoluble matter.	Calcium oxid.	Magnesium oxid.	Potassium oxid.	Residual sodium oxid.	Sulphur trioxid.	Phosphoric acid (P_2O_5).
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
19766	Juice from beef chuck at 60°C	12.37	0.45	0.89	0.10	47.85	5.91	3.37	33.22
19767	Juice pressed from sirloin steak	8.56	0.56	0.96	Trace.	45.67	2.71	1.56	37.12
19785	Juice extracted from sirloin steak by cold pressure	10.20	1.02	Trace.	Trace.	49.77	4.64	0.66	33.74
19786	Juice extracted from beef chuck by cold pressure	12.15	1.06	Trace.	0.49	47.30	8.03	0.74	29.56
19787	Juice extracted from beef chuck after 6 hours at 60° to 100° C	13.43	1.69	Trace.	0.37	51.58	9.46	1.91	34.20

The most striking point in the analysis of the ash of meat extracts is the large amount of potash salts present, practically one-half of the salt-free (NaCl-free) ash being composed of potassium oxid. The amount of phosphoric acid[d] is also high, amounting to fully one-third of the salt-free ash. The percentage of phosphoric acid given in the table may be low, as part of the organic phosphoric acid is volatile especially if the ash be heated to a very high temperature. The other constituents of the ash of meat juice are oxid of iron,

[a] Chemische Zusammensetzung der menschlichen Nahrungs- und Genussmittel. 1889. 3rd ed., *1*: 236.

[b] Compt. rend., 1879, *89*: 958.

[c] Mineral Stoffwechsel, Berlin, 1906.

[d] The provisional volumetric method was used—U. S. Dept. Agr., Bureau of Chemistry, Bul. 107, p. 16.

calcium, magnesium, and sodium. Phosphates and sulphates of calcium and potassium, organic sulphur, and a small amount of insoluble matter, principally silica, are also present.

In Table XII figures are given showing the composition of the ash of various meat extracts and miscellaneous preparations. As the percentage of sodium chlorid shown in Table XII is much greater than that present in the natural meat juice, the figures for the salt-free ash are correspondingly lower. The amount of insoluble matter is surprisingly high in several cases and it appears that some insoluble substance must have been added. For comparison the following results are quoted from König,[a] showing the average composition of the ash of meat extracts:

	Per cent.		Per cent.
Potassium	42.26	Phosphoric acid	30.59
Sodium	12.74	Sulphuric acid	2.03
Calcium	0.62	Silica	0.81
Magnesium	3.15	Chlorin	9.63
Oxid of iron	0.28		

Results of the analysis of the ash of meat peptones are also given. König states that the salts, especially the potash salts present in the ash of meat extracts, are valuable on account of their action on the nervous system.

TABLE XII.—*Analyses of the ash of meat extracts and miscellaneous preparations.*

Serial No.	Chlorin as sodium chlorid.	Composition of salt-free ash.								
		Insoluble matter.	Ferric oxid.	Calcium oxid.	Magnesium oxid.	Potassium oxid.	Residual sodium oxid.	Sulphur trioxid.	Phosphoric acid (P_2O_5).	Alkalinity (N/10 hydrochloric acid).
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*cc per 100 grams.*
18152	39.78	0.42	.....	0.27	0.35	53.44	7.31	5.50	23.26	79.71
18159	40.85	.22	.....	Trace.	Trace.	40.81	6.20	11.19	25.56	60.86
18161	63.47	.27	.....	1.42	.47	50.31	6.52	8.13	24.50	85.96
18434	41.39	4.66	.....	Trace.	.90	46.92	13.97	4.69	25.25	26.10
18435	82.13	.67	.....	1.62	Trace.	27.59	.....	21.94	23.84	49.80
18563	34.22	1.43	.....	Trace.	.17	45.53	8.47	2.19	23.99	.....
18584	53.23	1.62	.....	.26	.41	64.70	6.37	2.46	30.08	70.13
18623	75.27	0	.....	Trace.	Trace.	40.36	.....	.....	29.40	63.49
18624	33.64	.74	.....	Trace.	Trace.	50.51	10.02	3.47	22.30	80.47
19398	32.65	8.02	.....	.46	.56	51.36	4.08	2.55	24.29	.....
19399	46.65	9.05	.....	Trace.	Trace.	49.07	5.27	5.44	27.09	.....
19461	37.61	2.74	(*b*)	3.72	Trace.	39.01	13.24	15.18	26.05	68.76
19707	12.78	9.97	.....	Trace.	Trace.	42.85	10.40	2.59	22.70	.....
19818	12.24	3.01	(*c*)	Trace.	Trace.	41.21	9.64	2.96	20.75	55.04
18460	12.21	29.38	.....	.32	Trace.	27.59	6.99	1.81	26.37	43.06
18633	42.34	5.38	.....	7.80	16.82	3.17	3.40	16.30	.69	.....
18636	22.93	1.70	.....	Trace.	.18	43.88	4.76	3.48	28.31	65.91
19458	30.88	.61	.....	9.33	.95	30.22	6.03	5.30	37.53	107.64
19460	12.21	29.38	.....	.32	Trace.	27.59	6.99	1.81	26.37	43.06
19465	49.97	5.74	.....	.64	.54	45.75	4.94	3.70	32.18	.....
19467	57.17	1.35	(*b*)	Trace.	Trace.	47.02	5.23	10.60	29.65	.....
18629	47.33	11.35	.....	.59	Trace.	46.82	18.36	2.56	27.51	.....
18635	54.80	17.28	.....	Trace.	Trace.	39.00	9.09	4.51	23.98	75.66
18637	53.98	.65	.....	Trace.	Trace.	49.63	18.99	2.33	36.05	79.10
19817	48.02	3.46	.....	Trace.	Trace.	32.42	9.22	6.25	24.53	33.31
18877	39.48	14.11	.....	Trace.	.17	34.96	7.72	3.27	16.86	.....

[a] Loc. cit. [b] Present in small amount. [c] Present.

SEPARATION OF ORGANIC AND INORGANIC PHOSPHORUS.

The 10:1 ratio of total phosphoric acid to organic phosphoric acid suggested by Siegfried and Singewald [a] is not constant. This method should be further investigated before applying it to all extracts and food products in general. The high inorganic phosphoric acid content in some cases might be explained by the fact that phosphates may have been added, but we should hardly expect this in the case of organic phosphorus.

The method of Siegfried and Singewald for the separation of the organic from the inorganic phosphorus was applied to meat extracts in the following manner:

Dissolve an amount of the original sample corresponding to 10 grams of the water-free material in water in a 300 cc flask. Add 50 cc of barium chlorid (10 per cent solution) and 10 cc of ammonia (10 per cent solution). Make the solution up to the mark and thoroughly shake. Allow to stand and employ an aliquot of 250 cc of the filtrate for the estimation of phosphorus by the peroxid method to obtain the amount of phosphorus present in organic form. This figure subtracted from the amount of total phosphorus gives the amount of phosphorus in the inorganic form. The accuracy of the method is questionable as the filtrate in the majority of cases was cloudy, and sometimes the slow filtration renders the method extremely tedious.

ACIDITY.

In the average solid or pasty extract the lactic acid content varies from 4 to 8 per cent, and, as a rule, the extract showing the highest phosphoric acid content likewise shows the highest acidity. This is undoubtedly due to the fact that some of the phosphoric acid is in the form of dihydrogen or acid phosphate, although the character of the acidity has not been definitely determined.

The method employed for determining acidity consisted in adding tenth-normal sodium hydroxid to a dilute solution of the meat extract in water until a drop removed by means of a small capillary tube and tested on a piece of litmus paper gives a neutral reaction. The results are expressed in cubic centimeters of tenth-normal sodium hydroxid, also as per cent of lactic acid present. It is recognized that the acidity of meat extracts is due to various causes, but lactic acid is the predominating acid, and the results for acidity are usually expressed in the case of such products as per cent of lactic acid. (See Tables I, III, and IX.)

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[a] Zts. Nahr. Genussm., 1905, *10*:521.

NITROGENOUS BODIES.

Classes of Nitrogenous Constituents and General Methods of Separation.

It is believed that the proteids are made up of molecules of extreme complexity—hundreds of atoms of carbon, hydrogen, oxygen, and nitrogen—but the arrangement of these atoms and their number have not been definitely determined. Various proteid substances are spoken of, for example, albumins and peptones, as pure chemical substances, but it is impossible at present to prepare two specimens of egg albumin exactly alike, and in the case of peptones even more difficulty is encountered. Because certain nitrogenous bodies give color reactions that are alike and exhibit a few points in common, they are grouped together under a definite term. It is not surprising, therefore, that the methods for the separation of nitrogenous bodies are far from satisfactory in many cases.

Professor Mallet[a] says the following classes of the nitrogenous constituents of food are commonly recognized as requiring separate consideration:

1. Proteids proper (by some called albuminoids), and their closely related derivatives, the proteoses and peptones.
2. Gelatinoids or collagens, and allied substances immediately derived from them, such as gelatin, chondrin, etc.
3. Simpler amids, amido-acids, and allied substances, such as the asparagin, glutamin, etc., of vegetable materials, and the "flesh bases" (kreatin, kreatinin, etc.) of animal origin.
4. Alkaloids, or amine-like compounds of well-determined basic character.
5. Ammonia and its salts.
6. Nitrates.

To these, no doubt, should be added lecithin and analogous substances containing nitrogen, but closely allied to the fats.

The average nitrogen content of the pasty or solid extracts usually varies from 6 to 9 per cent. The nitrogen in the so-called meat juices is subject to much greater fluctuation, depending largely on the content of solids. Although a high nitrogen content is not a guarantee of the character or mode of manufacture of an extract, an average nitrogen content is desirable.

All nitrogen determinations were made by T. C. Trescot.

Several new determinations were applied to the analysis of meat products. These include the separation and estimation of the meat bases by a modification of the Schjerning tannin-salt method,[b] the determination of kreatin and kreatinin by the colorimetric method of Folin,[c] the determination of xanthin bases by the method of Schittenhelm,[d] the estimation of ammonia by the magnesium oxid method,[e]

[a] U. S. Dept. of Agr., Bureau of Chemistry, Bul. 54, page 7.
[b] J. Amer. Chem. Soc., 1906, *12*:1485.
[c] Zts. physiol. Chem., 1904, *41*:223.
[d] U. S. Dept. Agr., Bureau of Chemistry, Bul. 90, page 129.
[e] U. S. Dept. Agr., Bureau of Chemistry, Bul. 107, page 9.

the determination of total phosphorus by the peroxid method,[a] and the separation of the organic from the inorganic phosphorus by the method of Siegfried and Singewald,[b] described under ash. Sodium chlorid was estimated by the Volhard method.[c]

The methods of the Association of Official Agricultural Chemists were used in most cases.[d] For the determination of total nitrogen, total meat bases, xanthin bases, and insoluble and coagulable proteids aliquots of one solution of the sample were used. The peptones were determined by the tannin-salt method[e] and the kreatinin[f] by a modification of Folin's method (page 39).

Many reagents have been used to separate the meat bases from the nitrogenous bodies of larger molecular weight. Phosphotungstic acid has been more widely employed than any of the others, but is known to precipitate many of the diamido acids,[g] and its power to precipitate completely the peptones[h] is not established. Mallet[i] states that the use of phosphotungstic acid as a precipitant, followed by washing the precipitate with hot water, seems to effect a separation of all the simpler amidic substances from the proteids and proteid-like bodies, excepting only the peptones. Mallet quotes authority to show that the peptones are precipitated by tannic acid. The method was tried in the present investigation, but was discarded. Bromin has been suggested by Allen and Searle[j] as a reagent for separating the higher amido bodies from the lower amido acids, but it has been found by Schjerning[k] and others to be unreliable. That the tannin-salt reagent makes an absolute separation is not claimed, but it seems to be the best at present available.

Insoluble and Coagulable Proteids.

In Table XIII figures are given showing the amount of nitrogen present in the insoluble form as distinguished from that present in the coagulable form. This separation was made on seven extracts included in Table VII (miscellaneous preparations), which showed high coagulable nitrogen figures. The provisional methods[l] of the Asso-

[a] J. Amer. Chem. Soc., 1904, *26*:1108.

[b] Zts. Nahr. Genussm., 1905, *10*:521.

[c] Liebig's Annalen, 1878, *190*:1.

[d] U. S. Dept. Agr., Bureau of Chemistry, Bul. 107.

[e] U. S. Dept. Agr., Bureau of Chemistry, Bul. 99, p. 182.

[f] All kreatinin figures refer to kreatinin and kreatin estimated as kreatinin after dehydration.

[g] Hammarsten, Physiological Chemistry, 1904, p. 80.

[h] U. S. Dept. Agr., Bureau of Chemistry, Bul. 73, p. 92.

[i] U. S. Dept. Agr., Bureau of Chemistry, Bul. 54, p. 21.

[j] Analyst, 1897, *22*:258.

[k] Zts. anal. Chem., 1900, *39*:545. U. S. Dept. Agr., Bureau of Chemistry, Bul. 81, p. 104.

[l] U. S. Dept. Agr., Bureau of Chemistry, Bul. 107, p. 115.

ciation of Official Agricultural Chemists for meat fiber and coagulable proteids in meat extracts were followed.

The amount of insoluble material in several instances is extremely large and the name "extract" hardly applies to such products. The amount of coagulable proteid in sample No. 17882 is very high. No insoluble material should be present in a properly prepared extract. As noted under meat juice, however, the coagulable proteid is the characteristic form of nitrogen for such products. Meat extracts, both the solid and liquid, contain some coagulable proteid.

TABLE XIII.—*Separation of insoluble and coagulable nitrogen.*

Serial No.	Nitrogen as—			Expressed in terms of total nitrogen.		Remarks.
	Total.	Insoluble proteid.	Coagulable proteid.	Insoluble proteid.	Coagulable proteid.	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
17879.....	4.57	1.16	0.141	25.38	3.09	Same brand as 15910, Table VI.
17880.....	8.505	3.15	.015	37.04	.17	Same brand as 15909, Table VI.
17881.....	2.015	.312	.619	15.48	30.72	Same brand as 16043, Table VI.
17882.....	2.435	.013	2.32	.53	95.28	Same brand as 15989, Table VI.
17884.....	3.22	1.66	.02	51.55	.62	Same brand as 16037, Table VI.
17885.....	6.315	.202	.029	3.19	.46	Made by company manufacturing 16041, Table VI, but an entirely different product, as stated on label.
17887.....	5.81	1.13	.021	19.45	.36	Same brand as 15963, Table VI.

PROTEOSES AND PEPTONES.

The following tentative standard for peptones has been framed by the standards committee:

Peptones are products prepared by the digestion of proteid material by means of enzymes or otherwise, and contain not less than ninety (90) per cent of proteoses and peptones.

The proteoses and peptones are nitrogenous bodies of smaller molecular weight and greater solubility and diffusibility than the albumins. They are prepared from the albumins by the process of hydration. The peptones are below the proteoses in the process of hydrolysis. The distinction between the proteoses and peptones usually considered is that made by Kühne,[a] who defined the proteoses as nitrogenous bodies precipitated by ammonium sulphate, while the peptones are not precipitated by this reagent. These two bodies also differ in solubility and as to certain chemical reactions.

The zinc sulphate method[b] was employed for the determination of the proteoses. The peptones were precipitated together with the proteoses by the tannin-salt reagent[c] and the peptone figures obtained by difference.

[a] Zts. Biol., 1886, *22*:423.

[b] U. S. Dept. Agr., Bureau of Chemistry, Bul. 107, p. 115.

[c] U. S. Dept. Agr., Bureau of Chemistry, Bul. 99, p. 182.

In regard to the nutritive value of the albumoses and peptones much uncertainty exists, but many investigators, as Munk,[a] Deiters,[b] Zuntz,[c] Pollitzer,[d] and others, have shown that pure albumoses and peptones can replace proteid matter of equivalent nitrogen content.

The nature of the proteoses, as precipitated by saturating a sample of Liebig's meat extract with zinc sulphate, was lately investigated by Micko,[e] who applied the Fischer ester method to the proteoses. He identified the following amido bodies by this method: Glycocoll, leucin, isoleucin, alanin, amido valerianic acid, prolin (racemic and active), asparaginic acid (racemic and dextrorotatory), glutaminic acid anhydrid, and phenylalanin. No xanthin or kreatin was found in the proteose precipitate.

Gelatin.

General discussion.

The addition of gelatin to meat preparations has been practiced in the past. By this means the manufacturer increased or maintained a certain nitrogen content, but supplied the nitrogen in a form lacking in stimulating effect and probably in nutritive value. The buyer was consequently deprived of the characteristic essentials of a true meat product, although the nitrogen content was relatively high. In many cases only a small proportion of the added gelatin existed in the extract as such, as it was converted by a gradual process of hydration into gelatoses and gelatin peptones. While the methods for the separation of gelatin from proteid matter are far from satisfactory, it is a much simpler process than the detection of gelatoses and gelatin peptones and their separation from the albumoses and peptones, no satisfactory method for the separation of these bodies being known.

Some gelatin may be formed in the preparation of a high-grade extract of meat, although with proper precautions there should be practically none present. When a sufficient amount of gelatin is present it is readily detected by the setting qualities of the extract after warming. The power of gelatinizing is only possessed by unaltered gelatin; its dissociation products do not have this power.

Micko[f] has recently studied the gelatin cleavage products and finds that practically the same bodies are formed on hydrolysis as in the case of the albumoses. In both cases glycocoll predominates. This investigator states that no gelatin is present in Liebig's extract

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[a] Therap. Monatsh., June, 1888. Deutsche med. Wochenschr., 1889, No. 2.
[b] Von Noorden's Beiträge zur Lehre vom Stoffwechsel, 1892, p. 47.
[c] Arch. gesam. Physiol., 1885, *37*:313.
[d] Ibid., p. 301.
[e] Zts. Nahr. Genussm., 1907, *14*:253.
[f] Ibid., p. 284.

but the soluble forms (glutin and gelatoses) are present, being formed by action of the lactic acid on the gelatin.

The following tentative standard has been framed by the food standards committee:

Gelatin (*edible gelatin*) is the purified, dried, inodorous product of the hydrolysis, by treatment with boiling water, of certain tissues, as skin, ligaments, and bones, from sound animals, and contains not more than two (2) per cent of ash and not less than fifteen (15) per cent of nitrogen.

EXPERIMENTAL WORK ON METHODS.

Experiments were made to test the following gelatin methods: (1) the Stutzer ice-water alcohol method,[a] modified by Bigelow;[b] (2) the Beckmann[c] formaldehyde method; (3) the trichlor-acetic-acid method of Obermayer.[d]

The gelatin used in these experiments was a product of good quality used in preparing culture media. With Millon's reagent it gave a faint pink reaction in the cold, and upon heating a red color developed, showing some proteid matter was present. This reaction shows the presence of tyrosin, and as pure gelatin contains no tyrosin, a small amount of proteid must have been present as an impurity. The biuret test gave a faint reaction with the gelatin solution.

The solution of gelatoses and gelatin peptones used was prepared by treating some of the gelatin with weak (3 or 4 per cent) hydrochloric acid for four days on the steam bath. This solution also gave the Millon and biuret tests. Neither the gelatin nor gelatose solutions showed signs of gelatinizing. The former was of 1.14 per cent and the latter of 0.64 per cent strength.

The modified Stutzer method gives, in the case of pure gelatin solutions, a rough approximation of the amount present, the results showing that about 84 per cent are recovered. With a solution of gelatoses and gelatin peptones, this method gives about 3.6 per cent of the nitrogen present as gelatin nitrogen. This may be due to a trace of gelatin in the gelatose solution. In the case of Witte's peptone 19 per cent of the total nitrogen appears as gelatin nitrogen according to the modified Stutzer method. It seems that the absolute alcohol precipitates a portion of the albumoses present in Witte's peptone. In the case of the meat extract used, 3.7 per cent of the nitrogen is estimated as gelatin nitrogen by this method. Mixtures of gelatin with gelatoses, Witte's peptone, and meat extract were made in various combinations; also mixtures of the meat extract, Witte's peptone, and gelatose without gelatin. The results for gela-

[a] Zts. anal. Chem., 1895, *34*: 568.
[b] U. S. Dept. Agr., Bureau of Chemistry, Bul. 107, p. 116.
[c] Analyst, 1895, *20*: 44.
[d] Zts. anal. Chem., 1890, *29*: 114.

tin were very irregular and inaccurate, and in all cases only a portion of the gelatin added was recovered. It is evident that the presence of albumoses and peptones, as well as of gelatoses and gelatin peptones, tends to dissolve the gelatin and give low results by this method.

The Beckmann formaldehyde method,[a] together with some comments thereon, reads as follows:

A method for the estimation of gelatin in meat extracts is based upon the fact that formaldehyde combines with it to form a nonfusible and insoluble compound—formalin-gelatin. In order to render insoluble 1 gram of gelatin dissolved in water about two drops of the 40 per cent solution in water of formaldehyde (formalin) are added. The quantity required is so trifling that its weight may be neglected.

The presence of much free acid hinders the reaction, which, however, takes place perfectly well in a slightly alkaline solution. * * * If formic or acetic acid be present, either too little precipitate is obtained or none at all. * * * Soluble egg-albumin and serum albumin left residues on mixing with formalin. * * * Merck's dry peptone was found to be completely soluble in the presence of formalin, and by this means gelatin and albumin could be easily separated from peptone. * * *

In determining whether a meat extract contains gelatin, the albumin is estimated in an aliquot part of a watery solution by means of acid. Another portion is treated with formalin, steamed on the water bath, and, after boiling for a short time with water, the residue is collected in a Gooch crucible, dried at 100° C., and weighed. After subtracting the amount of albumin previously found, this gives the gelatin. The peptone, etc., in the filtrate can be precipitated in the usual way. The method will be of use in milk analysis for detecting adulteration with an emulsion of gelatin and fat.

The results obtained by this method were not satisfactory, and confirm the results obtained by Stutzer. All of the solutions were filtered hot. The gelatin does not seem to form an insoluble formalin-gelatin as described by Beckmann and the gelatin results were extremely low. In the case of meat extract and Witte's peptone, some nitrogenous matter was precipitated by the formaldehyde, the latter giving quite a large precipitate. When the gelatose solution was used, practically no precipitate was obtained. On mixtures of these various substances, either alone or in the presence of gelatin, only incomplete results were obtained.

Obermayer agrees with Raabe[b] in stating that trichloracetic acid will precipitate albumin and albumin peptones and thus affords a separation from other peptones, such as gelatin peptones, which are only precipitated by this reagent in concentrated solution.

The trichlor-acetic-acid method for precipitating gelatin as outlined by Obermayer is briefly as follows:

Precipitate the solution with an excess of trichlor-acetic acid, and wash the precipitate with dilute sulphuric or hydrochloric acid. Thoroughly extract the precipitate with alcohol, then with ether, dry and weigh the precipitate. According to Obermayer, the albu-

[a] Report of Thirteenth Assembly of Bavarian Chemists, 1894, pp. 18–20.

[b] Zts. anal. Chem., 1882, *21*: 303.

mins and gelatin, as well as the albumin and gelatin peptones, are precipitated by this reagent. In an excess of the reagent the albumin peptones are soluble, while the gelatin peptones are not.

A 10 per cent solution of trichloracetic acid was prepared and its action tested on the following nitrogenous bodies: (1) Gelatin; (2) a mixture of gelatoses and gelatin peptones; (3) Witte's peptone (albumose and peptone preparation); (4) meat extract. The results of the test are as follows:

In the case of the gelatin sample ten drops of the reagent gave a slight precipitate, while the other three nitrogenous substances examined gave no precipitate. An excess of the reagent gave a heavy white precipitate with gelatin and Witte's peptone, a smaller precipitate in the case of the meat extract (the reaction being obscured by the dark color of the solution), while the gelatose solution showed only a slight turbidity.

It is evident from these results that trichloracetic acid does not precipitate the gelatoses, neither when a small amount nor when an excess of the reagent is used. The gelatoses are precipitated by the tannin salt reagent and it is possible that a method for estimating the gelatoses may be worked out on the basis of the trichloracetic acid reagent.

Total Meat Bases.

The meat bases contain from 40 to 60 per cent of the nitrogen in solid meat extracts, as is shown in Table III. In one of the poorest extracts examined, but 3.82 per cent of the total nitrogen is present in this form.

The meat bases are divided into two general classes, the mono- and the di-amido acids. By the method of analysis employed, the meat bases are found in the filtrate from the tannin-salt precipitate. Some of the meat bases, for example, kreatin and kreatinin, and the hexon and xanthin bases are well defined chemical bodies that have been isolated and analyzed, but a considerable number of the nitrogenous bodies classed as total meat bases are of unknown constitution and are classed as undetermined nitrogenous matter.

Many new bodies have been found in meat extract in recent years. Kutscher[a] has recently found the following nitrogenous bodies: Ignotin, methyl guanidin, carnomuscarin, neosin, novain, and oblitin. Krimberg[b] has demonstrated the presence of carnosin, carnatin, and methyl guanidin in flesh. Micko[c] applied Fischer's ester method to Liebig's extract and found alanin, leucin, and glycocoll in abundance. No amido valeric acid was found, and most of the amido acids were left in a sirupy mass.

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[a] Zts. Nahr. Genussm., 1905, *10*:528.
[b] Zts. physiol. Chem., 1906, *48*:412.
[c] Zts. Nahr. Genussm., 1902, *5*:193.

Intermediate between the peptones and the amido acids is a class of substances, recently described by Fischer,[a] called peptids, which are divided into two classes, the dipeptids and the polypeptids. The importance of Fischer's work can not be overestimated, as a beginning has thus been made in the important problem of determining the construction of the proteid molecule.

Kreatin and Kreatinin.

Application of kreatinin test to meat extracts.

Kreatin and kreatinin are two amido bodies which characterize meat and therefore they are natural and essential constituents of meat preparations. The other meat bases are important constituents of an extract of beef, but occur in smaller amounts.

As kreatin is the principal amido body found in meat, we expect to find it, together with kreatinin, its dehydrated form, in still larger quantities in meat extracts. In several cases in which the extract acted suspiciously, no kreatin was found, and grave doubts exist as to the source of such products. True meat extracts give high kreatin and kreatinin results, as well as high figures for meat bases. The estimation of the kreatin and kreatinin is, therefore, a very important determination and of great value in determining artificial and imitation meat and yeast products, and in establishing the source and purity of an extract of meat.

The determination of kreatin and kreatinin was carried out as follows: Use an aliquot of the filtrate from the insoluble and coagulable proteid determination, the amount depending on the character of the extract.[b] The aliquot must contain sufficient total kreatinin, after dehydration of the kreatin to kreatinin, to give a reading not far from 8° on the scale of the Dubosc colorimeter after applying the colorimetric method as outlined by Folin[c] for the estimation of kreatinin in the urine. Heat this aliquot with 5 cc of half-normal hydrochloric acid for three and a half hours on a steam bath under a reflux condenser. Neutralize the hydrochloric acid by the addition of 5 cc of half-normal sodium hydroxid, then add 15 cc of a saturated picric acid solution, and 5 cc of 10 per cent sodium hydroxid. Shake the solution and allow it to stand for five minutes; make up to 500 cc and compare the color with a half-normal solution of potassium bichromate in the Dubosc colorimeter. The half-normal bichromate solution when the scale is set at 8° corresponds to 10 mg of kreatinin and from this figure the amount of kreatinin in the aliquot is readily calculated.

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[a] Untersuchungen über Aminosäuren, Polypeptide und Proteïne (1899–1906), Berlin, 1906.

[b] Aliquot should represent approximately 0.2 gram of a first class, solid beef extract.

[c] Zts. physiol. Chem., 1904, *41*:223.

Definite amounts of kreatin and kreatinin were added to samples of meat extracts and practically the entire amounts added were recovered by this method. The color of the various extracts interfered slightly with the reaction and attempts were made to remove the color by precipitating with basic acetate of lead and phosphotungstic acid and by filtering through animal charcoal. In all such cases, however, low results were obtained on testing the filtrate for kreatinin. Consequently, in this work the kreatinin method was applied directly to the coagulable proteid filtrate and no allowance was made for the error due to the color. Since the method calls for a dilution to 500 cc and but 10 to 15 cc are used for the determination, this error is negligible. Grindley and Woods[a] have determined separately the kreatin and kreatinin content of several extracts of meat and found both present in varying amounts. It is necessary, therefore, to determine these two bodies separately when a careful study of the nitrogenous bodies of meat extract is made. Some later experiments in the Bureau of Chemistry have shown that three and one-half hours heating in a boiling water bath is necessary for the complete conversion of kreatin into kreatinin. Benedict and Myers[b] have described a rapid method for the estimation of kreatin and kreatinin by conversion into kreatinin in an autoclave. This method reduces the time of dehydration of the kreatin to fifteen minutes.

APPLICATION OF KREATININ TEST TO TANNIN-SALT FILTRATE.

In view of the fact that a portion of the kreatin in a sample of meat extract is precipitated by the tannin-salt reagent[c] the total kreatin and kreatinin in the filtrate from the tannin-salt precipitate is determined, as well as the total kreatinin in the extract, before adding the reagent. A more correct figure is accordingly obtained for the total meat bases by adding to the total meat bases figures the amount of total kreatinin precipitated by the tannin-salt reagent. In applying the Folin method to the filtrate of the tannin-salt precipitate considerable difficulty was encountered. The tannin was removed by means of baryta and the barium with sulphuric acid. After neutralizing, the total kreatinin was determined in the usual manner. In the estimation of the peptones, correction must likewise be made for the amount of kreatin and kreatinin precipitated by the tannin-salt reagent.

XANTHIN BASES.

In addition to kreatin and kreatinin, a true meat extract or meat juice should contain small amounts of xanthin bases, including xanthin, hypo-xanthin, guanin, and adenin. These bodies are de-

[a] J. Biol. Chem., 1907, *2*:309.
[b] Amer. J. Physiol., 1907, *18*:397.
[c] J. Amer. Chem. Soc., 1906, *28*:1485.

rived from the nuclei of the cells, and, consequently, in an extract that is prepared from fresh, unaltered beef a certain amount of these bodies should be obtained together with the salts and other extractive matter. The determination of the xanthin bases is, therefore, of value in determining the origin of an alleged extract of meat.

The xanthin base figures in the tables show a variety of results, which is explained by the fact that in the preparation of the extract under certain conditions of heat and pressure some of these bodies are destroyed. The following modification of Schittenhelm's method was employed for their determination:

Use an amount of the standard solution equivalent to 5 grams of the original extract. Place in a large evaporating dish and add 500 cc of 1 per cent sulphuric acid. Evaporate to 100 cc within 4 to 5 hours. Cool and neutralize with sodium hydroxid. Add 10 cc of 15 per cent sodium bisulphate, and 15 cc of 20 per cent copper sulphate; allow this to stand over night, filter, and wash. The precipitate suspended in water is treated with sodium sulphid and warmed on the steam bath. Add acetic acid to acidify and filter hot. To the filtrate add 10 cc of 10 per cent hydrochloric acid and evaporate to a volume of about 10 cc. Filter, make ammoniacal, and add ammoniacal silver nitrate of 3 per cent strength. After standing several hours the solution is filtered and washed with distilled water until no longer alkaline. The nitrogen in the precipitate is that of the xanthin bases.

Ammonia.

Ammonia in meat extracts is determined by the method[a] of the Association of Official Agricultural Chemists, which consists in distilling the sample in the presence of magnesium oxid. In several of the samples examined high ammonia results were obtained which might indicate some degree of putrefaction. It is questionable, however, whether the ammonia results obtained by the magnesium oxid method are not too high.

Many investigators have stated that ammonia salts are present in meat extracts. Probably the ammonia combines with acids of the fatty series to form these salts, which are soluble in alcohol and volatile with alcohol vapor. The ammonia is estimated by dissolving 10 grams of the meat extract in water, adding barium carbonate and distilling. It has been suggested that ammonium salts, especially ammonium sulphate, are added to meat preparations to increase the nitrogen content, and in some of the extracts examined a relatively high sulphur content was noted.

Succinic acid.

Weidel[b] first called attention to the presence of succinic acid in meat extracts. Salkowski,[c] Kutscher and Steudel,[d] and others claimed

[a] U. S. Dept. Agr., Bureau of Chemistry, Bul. 107, p. 9.
[b] Liebig's Annalen, 1871, *158*:353.
[c] Zts. klin. Med., 1890, Supplement to vol. 17, p. 77.
[d] Zts. physiol. Chem., 1903, *38*:101.

that succinic acid was a putrefaction product and its presence in meat extract showed that fresh meat had not been used in manufacturing the extract. Siegfried[a] held that the source of the succinic acid is a definite substance of acid character and he called this substance "Phosphorfleisch Säure" or "Muskelnucleon." Later work, however, indicates that succinic acid is a cleavage product of fresh meat formed by the action, at high temperature, of dextrose or other reducing substance on amido acids, especially aspartic acid. Consequently, the presence of succinic acid in a meat extract does not mean that spoiled meat was used in its manufacture. In 1904 two or three brands of American meat extract were tested for the presence of succinic acid by means of ether extraction and the pine sliver test and this body was shown to be present.

The question of the presence of succinic acid in meat extracts is thoroughly discussed in a recent publication of the German Board of Health.[b]

ETHER EXTRACT.

The ether extract should not be above 0.6 per cent in a sample of meat extract, as the fat is liable to become rancid and injure the flavor of the product. Moreover, a high fat content shows lack of care in preparing the extract.

The provisional method employed for determining the ether extract[c] is conducted as follows:

Dry the sample over night in the presence of dry sand in a lead dish at the temperature of boiling water. Then thoroughly grind and extract the dried sample with anhydrous ether, in a continuous extraction apparatus for sixteen hours. Satisfactory duplicate results are obtainable by this method, but it is the opinion of the authors that the sample should be digested with pepsin and acid before extracting with ether, in order to break up the proteid matter and thus expose the fat to the action of the ether more completely.

GLYCEROL.

That glycerol has been added to fluid meat extracts and other similar preparations is well known, and it was found in several of the samples reported in this bulletin. The purpose in adding it seems to be to give the product additional smoothness and body. Moreover, glycerol is of considerable value as a preservative. Glycerol is burned in the body and thus becomes a source of energy, but it does not act as a proteid sparer.

Various methods were tried for the determination of glycerol in meat extracts and related products, including the method of the

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[a] Zts. physiol. Chem., 1903, *39*:126.

[b] Arb. kaiserl. Gesundheitsamte, 1906, vol. 24.

[c] U. S. Dept. Agr., Bureau of Chemistry, Bul. 107, p. 114.

Association of Official Agricultural Chemists [a] for the determination of glycerol in wines, and Lane's method, [b] as well as numerous extraction methods. Among the solvents used were benzol, amyl-acetate, gasoline, carbon tetrachlorid, carbon bisulphid, and acetone. All of these solvents extract varying amounts of meat bases, or extractives, and give different results on the glycerol present. The following reagents were used to precipitate the dissolved meat bases: Lead acetate, silver nitrate, and phosphotungstic acid. The best results were obtained by extracting with acetone, the meat bases being precipitated first with silver nitrate, followed by phosphotungstic acid. The glycerol in the filtrate was estimated by the Hehner [c] method.

Shukoff and Shestakoff [d] describe an acetone extraction method, but weigh the glycerol, and it is impossible to estimate this body in the case of meat extracts by weighing on account of the salts and extractives dissolved by the acetone and weighed as glycerol.

A method using anhydrous copper sulphate and extracting with acetone is now under investigation.

NITRATES.

A qualitative test for nitrates was made in 28 samples of meat extracts, meat peptones, fluid meat juices, and fluid extracts. The samples were collected in July, 1907, and in general represent the same brands as were used in the other studies.

The diphenylamin [e] test was used. The reagent was made by dissolving 1 part of diphenylamin in 100 parts of concentrated sulphuric acid. The test was applied as follows:

Transfer 1.5 grams of the semisolid, or 1 cc of the liquid extracts, to a 250 cc beaker and boil with animal charcoal for two or three minutes. Filter the solution hot and test one drop of the filtrate on a porcelain plate with three drops of the diphenylamin reagent. A blue color indicates nitrates, and the depth of color shows in a general way the amount of nitrates present.

Negative tests for nitrates were obtained in the case of 14 of the 28 samples examined. The results on the 14 samples giving posi-

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[a] U. S. Dept. Agr., Bureau of Chemistry, Bul. 107, p. 83.

[b] Unpublished. The method reads as follows:

Precipitate a known weight or volume with basic lead acetate, make up to a known volume with alcohol, filter, take an aliquot part, add a little anhydrous lime, distil nearly to dryness in a steam bath (keep the flask immersed), add an excess of anhydrous CaO, mix, moisten with alcohol to facilitate mixing if necessary, distil again on steam bath to combine water with CaO, and extract with two-thirds alcohol and one-third chloroform, as usual.

[c] J. Soc. Chem. Ind., 1889, *8*:4.

[d] Zts. angew. Chem., 1905, *18*:294.

[e] Arch. Hyg., 1884, *2*:373.

tive reactions showed in 6 cases a slight trace and in 8 cases a very strong reaction, indicating that the "liquor" from the parboiling of corned beef was used in their preparation. (See p. 13.)

UNDETERMINED MATTER.

Under this head are included nonnitrogenous organic matter as well as glycerol and carbohydrates. Glycerol has been considered under a separate caption. The amount of undetermined matter present depends on the mode of preparation of the extract; not more than 10 per cent should be present in a meat extract. Inosite and various amido acids, from which the nitrogen has been split off, also constitute a portion of the undetermined matter.

Several of the samples which gave a high per cent of undetermined matter were tested for starch, reducing sugar, and glycerol. The following qualitative results were obtained:

Qualitative tests for starch, reducing sugar, and glycerol.

Sample.	Starch.	Sugar.	Glycerol.
15910	Present	None	None.
15966	None	None	Present.
15977	Present	Trace	Present.
16041	Present	Present	None.
16048	None	None	Present.
16049	None	None	Present.

The albumose and peptone products which are high in undetermined matter, according to the tables, contain carbohydrates (starch and sugars). In the case of several of the fluid meat extracts, or juices, and in one or two solid extracts, glycerol is present.

HISTORICAL NOTE ON NUTRITIVE VALUES.

GELATIN.

It has long been known that gelatin is present in various amounts in meat extracts. The collagen of the muscle on hydration yields gelatin, and if the hydration be carried far enough soluble gelatin, gelatoses, and gelatin peptones are found. Gelatin, while rich in nitrogen, is not capable of keeping the body in nitrogenous equilibrium, since the nitrogen is not present in a form available to the body as in all true proteids. This has lately been explained by Kauffmann [a] on the ground that the gelatin molecule is lacking in the tyrosin, cystin, and tryptophane groups and that by feeding these amido bodies with gelatin animals are kept in nitrogenous equilibrium.

Kauffmann states that one-fifth of the proteid of a ration can be replaced by gelatin, but when used in large proportions the body is

[a] Pflüger's Arch., 1905, *109*;440.

not kept in equilibrium. This was demonstrated by an experiment conducted by the author on himself, and also on dogs. Mancini[a] has fed large amounts of gelatin and little proteid and claims that gelatin has a proteid sparing action. Murlin[b] has replaced two-thirds of the proteid nitrogen by gelatin in the case of both dogs and men reduced to a starvation level and finds the equilibrium is not changed by this substitution. Gelatin and its cleavage products have been studied by Chittenden and Solley[c] and Levene[d] among others.

A valuable contribution to the literature on the subject of the nutritive value of gelatin by Murlin[e] has recently appeared. The review of the literature here given is in part taken from this article. The experiments performed by this author were made on dogs and the fasting requirement of nitrogen was used as a working basis. Murlin states that the power of the organism to utilize gelatin as a proteid substitute depends to some extent on the proteid condition of the body at the beginning of the experiment, as well as upon the loss of proteid during its progress.

In the experiments with dogs as high as 58 per cent of gelatin nitrogen was substituted for proteid nitrogen, the amount varying with the diet. In the case of man, if two-thirds of the potential energy were in the form of carbohydrates it was found to be possible to supply 63 per cent of the total nitrogen in the form of gelatin nitrogen for a period of two days and maintain a daily retention of nitrogen of 0.71 gram.

Exact knowledge of the nutritive value of gelatin had its beginning in the researches of Carl Voit,[f] published in 1872. As early as 1860 Voit and Bischoff[g] had established experimentally the truth first perceived by Donders,[h] that gelatin reduces the proteid requirements of the body; but they were of the opinion at this time that it could perform all the work of proteids and replace them entirely in the diet. After Voit[i] had shown that a part only of the nitrogenous excreta is derived from the proteids of the body tissue, a portion coming from the "circulating" proteids, he again investigated the extent to which gelatin could be substituted for proteid, and reached the following conclusions:

Gelatin exercises its sparing power on the proteids both with large and with small quantities of proteid (meat) fed at the same time, and with small quantities in much

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[a] Arch. d. Farmacol. sperim., 1906, *5*: 309, 337.
[b] Proc. Soc. Exper. Biol. and Med., 1904, *2*:38.
[c] J. Physiol., 1891, *12*:23.
[d] Zts. physiol. Chem., 1904, *41*:8.
[e] Amer. J. Physiol., 1907, *19*:287.
[f] Zts. Biol., 1872, *8*:297.
[g] Die Gesetze der Ernährung des Fleischfressers, Leipzig, 1860.
[h] Die Nahrungsstoffe, Crefeld, 1853.
[i] Zts. Biol., 1869, *5*: 329.

higher degree than either fat or carbohydrates. It can be shown that large quantities of gelatin spare more proteid from combustion than do small quantities; that, however, proteid is lost from the body even if with large quantities of gelatin the greatest possible amount of fat be given. A direct laying-on of gelatin, either in the glutin-yielding tissues or in the proteid-forming tissues, is not possible, and it must therefore be assumed that when gelatin is formed in the body it is at the expense of proteid. Gelatin, for this reason, is capable of replacing proteids of the food only in part.[a]

Voit made no special attempt to set the limits within which proteid may be so replaced, but gives for a large dog these figures: 168 grams of dry gelatin spared 84 grams of dry flesh.[b]

The next investigation bearing on the comparative value of gelatin and proteid was that of Oerum,[c] who placed a dog on a daily diet of meat, starch, butter, and meat extracts; he then replaced all of the meat with enough gelatin to maintain the same nitrogen supply. He records a considerable increase in the nitrogen of the urine in the latter case.

Pollitzer,[d] in the course of some experiments undertaken to prove that the products of proteid digestion are to be classed with the proteids themselves, and not with the proteid-sparing foods merely, compared the effects of gelatin on the nitrogen output with those of horseflesh and its products of gastric digestion. He concludes that peptone and hemialbumose (prepared by Kühne's methods) have a nutritive value which is in "sharp contrast with the considerable loss of nitrogen which takes place after feeding an equivalent amount of gelatin."

Ganz[e] fed Paal's glutin-peptone and was able to cover more than half of the total nitrogen requirements therewith. Gerlach[f] also prepared a "glutin-peptone," and found that it is a good "sparing agent," but is not of itself able to replace proteid.

Munk[g] in a brief series of experiments attempted to find the "upper limit for the substitution of food proteid with gelatin," and reached the conclusion that at least half as much proteid must be fed as is destroyed by the animal in fasting, if nitrogen equilibrium is to be maintained.

Kirchmann,[h] in a very painstaking research with proteid-free gelatin, determined that the proteid destruction may be reduced under the influence of gelatin alone as much as 35 per cent, and that this maximum effect is obtained when 62 per cent of the body's energy requirement is supplied by the gelatin.

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[a] Zts. Biol., 1872, *8*:297.

[b] Ibid.

[c] Nordiskt medicinskt Arkiv, 1879, vol. 11, reviewed by Hammarsten in Maly's Jahresbericht für Thierchemie, 1879, *9*: 308.

[d] Archiv gesam. Physiol., 1885, *37* : 301.

[e] Quoted by Kirchmann, Zts. Biol., 1900, *40*:54.

[f] Die Peptone. Hamburg and Leipzig, 1891.

[g] Archiv gesam. Physiol., 1894, *58* : 309.

[h] Loc. cit.

Krummacher,[a] carrying the work begun by Kirchmann still further, found that when the entire energy requirement of the dog was covered by gelatin the total sparing was only 37.5 per cent of the fasting nitrogen. Applied to a man whose energy requirement is 2,500 calories daily Krummacher calculates that if 5 per cent of his requirements were supplied in gelatin (i. e. about 33 grams of dried and purified gelatin), the proteid destruction in his body would be reduced from 70 grams to about 56 grams, or, in other words, the 33 grams of gelatin would replace 14 grams of proteid.

Gregor[b] used gelatin in feeding infants in certain cases where excess of proteid was contraindicated, and concluded that with a diet containing 4.8 grams of nitrogen per day (of which "nearly all" was gelatin N), not more than half as much nitrogen was lost from the body as in starvation.

Brat[c] prepared a gelatose, which he identifies by Chittenden's[d] method as a deuterogelatose, and fed it to convalescent patients as a substitute for a portion of the proteid in their diets.

Mancini[e] studied the nitrogen balance of five convalescents from typhoid fever, while giving "large quantities" of gelatin. He observes a considerable retention of nitrogen, but doubts whether proteid nitrogen can be replaced by gelatin nitrogen.

Kauffmann[f] studied the replacing power of gelatin in a diet containing "only as much proteid (mainly casein) as is necessary with a sufficient supply of energy for maintenance of the body's condition." He concludes from his experiments on dogs that not more than one-fifth of the proteid in such a diet can be replaced by (pure) gelatin if nitrogen equilibrium is to be maintained. With one-fourth of the proteid nitrogen so replaced a small minus balance occurs. Kauffmann's paper is concerned chiefly with the attempt to bring gelatin up to the full nutritive value of proteid by adding to it the amido-acids which it lacks, but which casein contains.

Rona and Müller,[g] in attempting to confirm Kauffmann's results with gelatin, tyrosin, and tryptophan, found first "the smallest quantity of proteid nitrogen with which the animal could well get along," and then replaced one-fifth of this proteid (casein) with gelatin nitrogen. Their observation as regards the amount which would be replaced was quite in accord with Kauffmann's, for when gelatin was substituted for two-fifths of the casein there was a distinct minus balance.

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[a] Zts. Biol., 1901, *42*:242.
[b] Centralblatt für innere Medicin, 1901, *22*: 65.
[c] Deutsche medicinische Wochenschrift, 1902, p. 21.
[d] J. Physiol., 1891, *12*:23.
[e] Reale Accademie dei Fisiocritici di Sieni, 1905, *17*:667.
[f] Archiv gesam. Physiol., 1905, *109*:440.
[g] Zts. physiol. Chem., 1907, *50*:263.

The conclusions reached by the various investigators may be summarized briefly as follows: Gelatin can replace proteid only in part (Voit, Oerum, Pollitzer); it has, however, a high proteid-sparing effect, whether fed alone (Kirchmann, Krummacher), or with other foods (Voit, Oerum, I. Munk, Kauffmann, Rona and Müller) in infant feeding (Gregor), or in convalescence (Brat, Mancini); this proteid-sparing effect is exerted also by gelatin-peptones (Ganz, Gerlach) and gelatoses (Brat).

MEAT EXTRACTS AND JUICES.

The various protein bodies and amido acids are so closely associated that it is impossible to produce amido acids without producing albuminoses and peptones. Consequently, every commercial meat extract must consist partly of albuminoses, peptones, etc. The best extracts on the market to-day contain about 50 per cent of the total nitrogen in the form of meat base nitrogen. When a meat preparation contains only a small amount of its nitrogen in the form of meat base nitrogen, the term "extract" seems to be no longer applicable. And it is evident that the product represents much less meat than an extract with 50 per cent of its nitrogen in the form of meat base nitrogen, provided the total nitrogen in both cases is approximately equal. Moreover, it is necessary to distinguish between a meat extract containing large amounts of stimulating amido acids and relatively small percentages of albumoses, peptones, and insoluble proteid matter, and an extract (or, more properly, a meat product) which consists largely of albumoses, peptones, and insoluble matter and relatively small amounts of amido acids. The food value of this last group of products is undoubtedly greater than that of the former group, but they should not be classed as extracts because of their different nature. The value of the amido bodies as food is uncertain, but at least they furnish energy to the body. It appears, therefore, that the value of meat extracts lies principally in their stimulating qualities, the active principles of tea and coffee being on a similar basis.

The question of the nutritive value and relative worth of the various nitrogenous constituents of meat preparations is a much-discussed but unsettled problem. Beef juice prepared from fresh beef by pressure and heating and used unchanged is an ideal product, containing the extractives as well as a large amount of nutritive material. As a commercial product, however, it is impracticable. The higher forms of nitrogen, insoluble proteids, alkali and acid albumins, and coagulable proteids, as well as the unchanged proteids, are the most desirable forms for the healthy individual. The invalid may require partly digested proteids, such as proteoses and peptones. A large amount of nitrogen in this form should be avoided, as many

investigations have shown that diarrhœa and other disorders follow the feeding of peptones. The stimulating properties of the amido acids are most valuable in that they create an appetite and prepare the system for food.

The scope of this report will not permit of the exhaustive treatment of this subject, but brief mention is made of the following contributions as indicative of the tendency of the results obtained:

Bürgi[a] states that meat extracts are not foods, and that all material taken in this form is quickly eliminated. Only 4.57 per cent of the nitrogen, 14.85 per cent of the carbon, and 17.55 per cent of the energy content is retained. According to Rubner[b] meat extracts, after they have served their purpose of stimulating digestion, are eliminated from the body as rapidly as possible. W. H. Thompson[c] has fed arginin to dogs and found from 37.6 to 77 per cent in the urine; on injecting arginin 82 per cent appeared in the urine. A part of the arginin nitrogen appeared in the urine as ammonia. Voit[d] claims that the value of meat extracts lies in their flavor, which promotes the flow of the digestive juices. As the constituents of meat extracts are largely in a form ready for elimination, Rubner[e] holds that they have little food value.

Pfeiffer, Einecke, and Schneider[f] have fed asparagin to cows and report a favorable effect on the milk and its constituents, and W. Völtz[g] claims asparagin can replace proteid without lowering the quality of the milk and that it acts as a proteid sparer in herbivora. In omnivora its proteid sparing power is small and it seems to have no such power in carnivora but rather increases proteid cleavage. In feeding experiments with mice on a zein ration Willcock and Hopkins[h] found that on adding tryptophane to the ration the lives of the mice were lengthened. Henriques and Hansen[i] have maintained nitrogenous equilibrium on feeding hetero-albumose.

Rubner[j] discusses the alcohol-soluble and alcohol-insoluble portions of fluid beef. The nutritive value of fluid beef is considered at length and the author concludes that if enough of such product for an entire ration were taken the cost would be enormous. The claim that two teaspoonfuls of fluid meat have a nutritive value equivalent to one and one-fourth pounds of cooked meat is deemed correct. Two

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[a] Arch. Hygiene, 1904, *51*:1.
[b] Ibid, p. 19.
[c] J. Physiol., 1905, *33*:106.
[d] Stoffwechsel, 1882, p. 449.
[e] Zts. Biol., 1883, *19*:343.
[f] Mitt. landw. Inst. königl. Univ. Breslau. 1905, *3*:179.
[g] Fühlings landw. Ztg., 1905, *54* (2):41; (3):96.
[h] J. Physiol., 1906, *35*:88.
[i] Zts. physiol. Chem., 1906, *48*:383.
[j] Zts. Biol., 1879, *15*:485.

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teaspoonfuls of fluid meat weigh about 52 grams and are equivalent to 65 grams of pure meat free from fat and bones. Barker[a] recently published a thorough review of the question and has taken up several new points. In normal man the amido bodies do not appear in the urine to any extent; therefore, they must be of value, and the author believes they are synthesized into protein by the cells of the small intestine. W. Völtz[b] claims that amido bodies of different chemical constitution produce varying effects on the nitrogen and caloric balances of the body. The tightly bound NH_2 groups, holding an intermediate position in the molecule, such as are found in glycocoll, tend to increase the nitrogen retention less than the carboxyl NH_2 groups, which are more easily separated from the molecule. The amids in an ordinary diet give more favorable results than when fed alone. On feeding various amids to dogs the author obtained favorable results.

An unsigned article in the Pharmaceutische Zeitung[c] discusses the manufacture of meat extracts, and says that when meat (fat and bone free) is extracted with water by heating, the extract does not taste like the commercial meat extract, and is whitish, but after continued heating over an open fire and the addition of 30 per cent of salt, the commercial product, a brown aromatic extract with a characteristic taste, is obtained. In preparing meat juice, 1 pound of meat cut up and pressed yields 60 to 100 grams of a red-colored juice. Evaporate this at 60° C. in a vacuum to one-third its bulk and a slightly red solution with a taste of meat, but no salty taste, is obtained—a product differing from the commercial article. It contains 30 per cent of coagulable nitrogen. If a little of the solid commercial meat extract is added, we have the commercial meat juice. This article is answered by L. Geret,[d] who tells of the virtues of Liebig's extract. H. Otto[e] claims that meat extracts contain no nutriment, and that the fine odor and aroma of meat bouillon is destroyed in the commercial product.

The nutritive value of beef preparations is also discussed by Chittenden.[f] Liebig's and Armour's extracts were analyzed and found to consist largely of soluble extractives and inorganic salts of muscle tissue. The nitrogen is high but not to any extent available for the body's use, and according to Kemmerlich an animal fed on extract of beef will succumb quicker than an animal not fed at all. Extracts are useful on account of their stimulating and restorative value. The content of potash salts causes a quickened and stronger heart beat. An extract of beef is more like an alcoholic stimulant than a food. Meat juices such as Wyeth's and Valentine's, according to Chittenden, have little food value, resembling dilute meat extracts.

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[a] British Med. J., Oct. 27, 1907.
[b] Arch. ges. Physiol., 1906, *112*: 413.
[c] Pharm. Ztg., 1905, *50*: 197.
[d] Ibid., p. 316.
[e] Ibid., p. 350.
[f] Med. News, 1891, *58*: 716.

The explanation of the oxidation of the various amido acids in the body is now generally referred to the relative position and number of carbon atoms in the side chains. Schotten,[a] Pohl,[b] and Knoop[c] have investigated this point quite thoroughly. The extent to which the administration of various amido acids will maintain the nitrogen equilibrium was first investigated by Loewi,[d] who showed that the end products of digestion which no longer gave the biuret reaction are still able to replace the albumins destroyed during metabolism.

Abderhalden and Bergell[e] have shown that amido acids when given in moderate amounts (glycocoll up to 5 grams; alanin, 3 grams; leucin, 8 grams; phenylalanin, 3 grams) are completely destroyed in the body. Stolte[f] injected various amido preparations into a rabbit and found an increased urea output in all cases. According to Mann[g] the first change which the amido acids undergo in the body is probably that of oxidation, oxy-acids being formed as occurs in plants and in alcaptan-urea when tyrosin and phenylalanin are changed into homogentisinic acid. It is an open question whether the carbon chain, after the splitting off of the nitrogen which forms urea, breaks up still further or whether it is utilized in the building up of other nonnitrogenous substances, such as carbohydrates and fats. Wohlgemuth[h] by feeding rabbits with the inactive or racemised monoamido acids (such as tyrosin, leucin, aspartic acid, and glutaminic acid) found that the inactive acids become dissociated during metabolism in such a way that the component occurring normally in the body is oxidized as far as it can be assimilated while the abnormal component is excreted partly or completely in the urine.

The occurrence of monoamido acids in the urine during normal and pathological conditions has been studied by Abderhalden,[i] Abderhalden and Bergell,[j] Ignatowski,[k] Abderhalden and Barker,[l] and Erben.[m] Loewi and Neuberg[n] have studied the diamins of the urine. Since the discovery of the enzym erepsin in the intestine the idea is rather generally accepted that the proteid molecule is broken down in part, at least to the ammonia stage, and the ammonia and other groups are synthesized into the characteristic body protein through the agency of the epithelial cells of the villi of the small intestine and transported by the lympocytes through the blood stream to the tissues.

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[a] Zts. physiol. Chem., 1883, *8* : 60.
[b] Arch. exper. Path. Pharm., 1896, *37* : 413.
[c] Hofmeister's Beiträge, 1904, *6* : 150.
[d] Arch. exper. Path. Pharm., 1902, *48* : 303.
[e] Zts. physiol. Chem., 1903, *39* : 9.
[f] Hofmeister's Beiträge, 1903, *5* : 15.
[g] Chemistry of the Proteids, 1906.
[h] Ber. d. chem. Ges., 1905, *38* : 2064.
[i] Zts. physiol. Chem., 1903, *38* : 557.
[j] Ibid., 1903, *39* : 9, 464.
[k] Ibid., 1904, *42* : 371.
[l] Ibid., 1904, *42* : 524.
[m] Ibid., 1904, *43* : 320.
[n] Ibid., 1904, *43* : 355.

In a recent article on the physiological action of muscle extracts, J. G. Slade[a] states that muscle extracts were formerly supposed to represent the whole nutritive value of the meat, but recently all nutritive power has been denied them, and indeed, except for such traces of albumin, fat, or peptone as they may contain, it is difficult to see whence such food value would come. This author concludes that muscle extract has no stimulating effect upon man's central nervous system nor upon the power of performing physical work. If taken as a strong solution or in large amounts it is liable to cause purgation. In moderate doses it stimulates the action of the heart. This is not due to kreatin, xanthin, or urates. The movement of the plain muscles throughout the body is increased, which is probably due to ornithin and novain. Muscle extract in 0.5 per cent solution increases the power of the voluntary muscle, in 0.1 per cent solution it has no effect upon the efficiency of the muscle, and in 0.2 per cent solution this is decreased. Xanthin has an action corresponding to the first effect; that is, in saturated solution it increases the efficiency. Kreatin has no action on voluntary muscle. The effect of fatiguing a muscle before preparing an extract from it is to increase its extractives and increase the activity of the extract. If injected into animals it causes great languor, prostration, and all the symptoms characteristic of fatigue. Muscle extract administered as "beef tea" acts as a moderate diuretic to men and other animals. The diuresis is associated with vasodilatation of the kidney.

Dr. O. Dornblüth[b] discusses the preparation and composition of various meat extracts, powders, and other preparations. Nutrose and milk casein products are considered.

Dr. J. Price[c] gives a recipe for preparing home-made meat extract after the general plan of Liebig's original recipe. He considers that meat extract or juice prepared as he describes it is highly nutritious.

A. Brestowski[d] claims that meat extracts possess no food value, but on account of the meat bases, potassium phosphates, and their flavor they have value in increasing muscle activity and the secretion of the gastric juice. The food and therapeutic value of peptones is discussed.

Pawlow[e] says that muscle extract is a stimulant to an exhausted system and assists digestion. Pawlow has shown that muscle extracts are stomach stimulants and cause a flow of gastric juice. He found also that the individual extractives, such as kreatin and kreatinin, were

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[a] J. Physiol., 1907, *35* (3):163.

[b] Aerztliche Monatschrift, 1898, *2*:49.

[c] Philadelphia Polyclinic, 1894, p. 93.

[d] Medicin.-Chir. Centrbl., 1893, *28*:653.

[e] The Work of the Digestive Glands, 1897, translated from the Russian by W. H. Thompson, London, 1902.

ineffectual, and concluded that the specific substance causing the stimulation was not known.

Brunton[a] makes the following statement in regard to the effect of beef tea or beef essence:

> We find only too frequently that both doctors and patients think that the strength is sure to be kept up if a sufficient quantity of beef tea can only be got down; but this observation, I think, raises the question whether beef tea may not very frequently be actually injurious, and whether the products of muscular waste which constitute the chief portion of beef tea or beef essence may not under certain circumstances be actually poisonous. For although there can be no doubt that beef tea is in many cases a most useful stimulant, one which we find it very hard, indeed, to do without, and which could hardly be replaced by any other, yet sometimes the administration of beef tea, like that of alcoholic stimulants, may be overdone, and the patient weakened instead of strengthened.

Mays[b] asserts that beef tea is entitled to be called a nutrient because its action is the same as that of milk, or a 2 per cent solution of ox blood. In a later paper[c] he ascribes this nutritive value to the kreatin and kreatinin present.

Dr. Lehman[d] discusses the action and the toxicity of meat extracts and concludes that Liebig's extract is not a heart poison, but is rather an aid to the heart. Both in health and in sicknesss as much of the extract can be used by the body as the stomach can stand. Home-made meat extracts contain more potash than equivalent amounts of Liebig's extract.

Dr. Carl Voit[e] gives a very able discussion of meat preparations and considers them of great value as a condiment, but not as a food.

Dr. N. G. Vis[f] conducted a set of experiments on men, using a mixed diet, including beefsteak in the first period. For the beefsteak he substituted in the second period an equivalent amount of nitrogen in the form of sanatogen, a sodium-casein-glycerol-phosphoric-acid compound. There was an increased excretion of nitrogen in both urine and feces in the second period.

Frentzel and Toriyama[g] in opposition to Rubner find that of the proteid-free extractive material of meat about two-thirds takes part in metabolism in that it furnishes energy to the body.

Dr. Emil Bürgi[h] has studied the question of the heat and energy value of meat and meat extractives in the case of dogs. His results show that meat itself is a much more valuable source of energy than are the meat extractives.

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[a] The Practitioner, 1880, *25*:325.
[b] The Lancet, 1886, *1*:510.
[c] Ibid., 1887, *1*:257.
[d] Aerztliches Intelligenz, 1885, *32*:318.
[e] Münchener medic. Wochenschr., 1897, *44*:221.
[f] Ibid., 1898, *45*:257.
[g] Arch. Anat. Physiol., Physiol. Abt., 1901, p. 499.
[h] Arch. Hyg., 1904, *51*:1.

E. Kemmerich[a] made a study of South American meat extracts and peptones, and divides the proteid bodies of these substances into three groups, depending on their action in the presence of various percentages of alcohol: (1) gelatin substances precipitated by 50 per cent alcohol; (2) albumoses precipitated by 80 per cent alcohol; (3) the peptones remaining in solution. The extractives are also in solution with the peptones. The author suggests a separation based on the fact that the extractives and salts dialyze while the other bodies do not.

Frentzel and Schreuer[b] fed meat extracts to dogs and compared the results with those obtained when meat was fed. These authors believe that the proteid-free extractives of meat, to one-third of their total, take part in metabolism in that they produce heat and energy.

Dr. J. Forster[c] discusses Valentine's meat juice, and considers it of no more value than Liebig's as a food—that is, it is of value as a condiment.

Dr. R. Sendtner[d] gives analyses of some 12 meat extracts and bouillon extracts. He considers the original Liebig process extract to be the best and cheapest. Many of the bouillons and juices are diluted meat extracts.

Frentzel and Schreuer[e] have studied the calorific value of meats and meat meal. Dogs were used in the experiments. His results agree with Rubner's in showing that the calorific value of meat is higher than that of meat powders and extractives.

Dr. Jung[f] in an article on meat extracts and peptones discusses the various constituents of these bodies and methods for separating the same. The author believes that large amounts of gelatin and gelatin hydration products are present in some extracts, being included under the term "proteid" since no method for separating gelatin and its hydration products from the various proteid bodies is known.

CONCLUSION.

It is commonly assumed that proteids, gelatinoids, and the simpler amids have very different nutritive values, and, while all authorities would agree in assigning the highest value to the first of these, there is probably no small difference of opinion as to the order in which the second and third should be rated. In considering such a question, there should be separately taken into account relative digestibility or solu-

[a] Zts. physiol. Chem., 1893, *18*:409.
[b] Biedermann's Centrbl. Agr. Chem., 1902, *31*:391.
[c] Zts. Biol., 1876, *12*:475.
[d] Arch. Hyg., 1897, *6*:253.
[e] Arch. Anat. Physiol., 1901, p. 284.
[f] Chem. Ztg., 1900, *24*:732.

bility, capability of undergoing osmotic absorption, and oxidizability for the production of energy. At present, no definite numerical statement of the relative nutritive values of nitrogenous bodies of these three classes can be made. It seems much to be desired that more extended experiments than have so far been recorded should be made upon living animals (as far as possible upon human beings) to determine the utilization of both the gelatinoids and the simpler amids. The latter no doubt undergo oxidation to some extent in the animal body, and produce some energy in consequence. It is probably true of these simpler amidic substances that much larger quantities than analysis exhibits as constituents of the food consumed, or than analysis detects among the residue of food rejected from the body without having undergone complete oxidation, may be constantly formed among the earlier products of the metabolism of the proteids, and afterwards themselves undergo further change into the simpler and more stable forms of carbon dioxid, water, and urea.

In the animal body the amido acids are acted upon in two ways; that is, they are converted into the corresponding fixed acids or carbonic acid is split off, leading to the formation of Brieger's diamins, or it is possible for both of these processes to take place. Usually the albumins are converted in the alimentary tract by the four proteolytic ferments (pepsin, trypsin, erepsin, and arginase) into primary crystalline dissociation products, namely, the amido acids, which are absorbed in this form. Whether a part of the albumin taken as food can or can not be absorbed in the form of albumoses, peptones, and peptids remains to be determined.

Meat preparations of the sort included in this report are largely used by the sick and the young. Their use is recommended frequently by physicians who may not have taken the trouble to ascertain the true nutritive value of the product prescribed. It seems to be the general consensus of opinion among scientific investigators who have studied this question that the food value of these meat extracts is rather limited, and although they are a source of energy to the body they must not be looked upon as representing in any notable degree the food value of the beef or other meat from which they are derived. When prepared under the best possible conditions a commercial meat extract is, of necessity, in order that it may not spoil, deprived of the greater part of the coagulable proteids, which constitute the chief nutritious elements of the juice. It is fair to state that many manufacturers make no claim as to the food value of their preparations, only a comparatively few making extravagant statements as to the nutritive value of these products.

Preparations of this character are not wholly valueless in the sick room, for they possess stimulating qualities, and in the kitchen they

are useful on account of their flavoring properties. They are not, however, concentrated foods, having on the contrary but comparatively little nutritive value. The meat juice prepared from fresh meat, in the home or hospital, by continued heating at a low temperature, is far superior as a food to the commercial meat extracts and so-called meat juices.

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